Ministry of
Northern Development
and Mines
Ontario

Mines and
Minerals
Division

Precambrian Geology

Little Marshall Lake Area

by S.E. Amukun

Ontario Geological Survey
Report 267

1989

90-01855/

© 1989 Queen's Printer for Ontario
Printed in Ontario, Canada
ISSN 0704-2582
ISBN 0-7729-5999-4

Publications of the Ontario Geological Survey and the Ministry of Northern Development and Mines are available from the following sources. Orders for publications should be accompanied by cheque or money order payable to the *Treasurer of Ontario*.

Reports, maps, and price lists (personal shopping or mail order):
Public Information Centre, Ministry of Natural Resources
Room 1640, Whitney Block, Queen's Park
Toronto, Ontario M7A 1W3

Reports and accompanying maps only (personal shopping):
Publications Ontario
Main Floor, 880 Bay Street
Toronto, Ontario M7A 1N8

Reports and accompanying maps (mail order or telephone orders):
Publications Ontario, Ministry of Government Services
5th Floor, 880 Bay Street
Toronto, Ontario M7A 1N8
Telephone (local calls), 965-5300
Toll-free long distance, 1-800-668-9938

Canadian Cataloguing in Publication Data

Amukun, S.E.

Precambrian geology, Little Marshall Lake area

(Ontario Geological Survey report, ISSN 0704-2582; 267)
ISBN 0-7729-5999-4

1. Geology—Ontario—Little Marshall Lake Region.
I. Ontario. Ministry of Northern Development and Mines. II. Ontario Geological Survey. III. Title. IV. Series.

QE191.A48 1989 557.13'12 C89-099647-4

Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Northern Development and Mines does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

If you wish to reproduce any of the text, tables or illustrations in this report, please write for permission to the Director, Ontario Geological Survey, Ministry of Northern Development and Mines, 11th Floor, 77 Grenville Street, Toronto, Ontario M7A 1W4.

Parts of this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Amukun, S.E. 1989. Precambrian geology, Little Marshall Lake area; Ontario Geological Survey, Report 267, 70p.

Scientific editors: Guy Kendrick and Bojan Sifrer

Deyell-1000-89

Foreword

This report describes the results of a detailed geologic survey of part of the northeastern Wabigoon Subprovince. The area includes a volcanogenic massive sulphide occurrence at Marshall Lake. The report reinterprets earlier work: the area underlain by felsic metavolcanic rocks is significantly enlarged. This evaluation significantly raises the economic potential of the area.

V.G. Milne
Director
Ontario Geological Survey

90-01855/

Contents

Abstract 2

Résumé 3

Introduction 4
- Location and Access 4
- Mineral Exploration 4
- Previous Geological Studies 5
- Present Geological Survey 6
- Acknowledgments 6

General Geology 7
- Archean 8
  - Metavolcanics 8
    - Mafic To Intermediate Metavolcanics 9
      - Flows 9
      - Tuffs 20
      - Lapilli Tuff, Tuff Breccia and Pyroclastic Breccia 20
      - Rocks of Unknown Origin 21
    - Intermediate To Felsic Metavolcanics 21
      - Tuffs 21
      - Lapilli Tuff, Lapillistone, Tuff Breccia and Pyroclastic Breccia 21
        - Features Indicative of Specific Origins 22
        - Vesiculated Juvenile Material (Pumice) 22
        - Nonvesicular Juvenile and Nonjuvenile Lithic Fragments 24
        - Juvenile Crystals 24
      - Flows 24
      - Porphyritic (Spherulitic) Flow 26
      - Dikes of Quartz and/or Feldspar Porphyry and Felsite ... 27
      - Schists and Gneisses 27
      - Metamorphism 27
  - Metasediments 27
    - Clastic Metasediments 27
      - Sandstones 27
      - Mudstones 28
      - Schists and Gneisses 28
    - Chemical Metasediments 29
      - Iron Formation 29
      - Chert, Ferruginous Chert 29
  - Metamorphosed Intermediate to Mafic Intrusive Rocks 29
    - Marshall Lake and Little Marshall Lake Intrusions 29
    - Gabbroic-Dioritic Dikes, Sills and Pods 30
      - Lamprophyre 30
  - Intermediate to Felsic Intrusive Rocks 30
    - Summit Lake Stock 30
    - Granitic Sheets and Dikes 32
- Proterozoic 32
  - Mafic Intrusive Rocks 32
- Cenozoic 32
  - Quaternary 32
    - Pleistocene and Recent 32

Structural Geology 34
Regional Setting 34
Local Structure 34
Foliation, Lineation 34
Joints 34
Faults 34
Folds 35
Cleavage 36
Correlation between Geology and Aeromagnetic Data 37
Economic Geology 38
Mineral Deposits 38
General Geologic Setting 38
Metasomatic Alteration 38
Relationship of Mineralization to Geologic Features 39
Favourable Geological Features 39
Host Rock Association 39
Related Plutonic Rock Association 41
Associated Tectonic Features 41
Other Relationships 41
Economic Potential 42
Descriptions of Deposits and Properties 43
Callinan Flin–Flon Mines Ltd. (1955) (1) 43
Consolidated Marbenor Mines Ltd. (1955) (2) 44
Cox, Nolan (3) 44
Doucett, George (4) 44
Duchene, Roger (5) 45
Fayle, Richard (6) 45
Feeley, Vincent (1965) (7) 45
Galley, David R. (8) 45
Giant Gripp Mines Inc. and Imperial Oil Limited (9) 46
History of the Property 46
Jacobus Mining Corp. Ltd. 46
Marshall Lake Mines Ltd. 47
Min–Ore Mines Ltd. 47
United New Fortune Mines Ltd. 47
Vincent Feeley 48
Reid Mining Properties 48
Kendon Copper Mines Ltd. 48
History of Exploration 48
Geophysical Surveys 48
Diamond Drilling 48
Description of the Deposits 49
N.W.T. Copper Mines Ltd. 51
Geophysical Surveys 51
Diamond Drilling 51
Gonzales, Cecil 54
Giant Gripp Mines Inc.–St. Joseph Explorations Ltd. 54
Geophysical Surveys 54
Diamond Drilling 54
McDermott, Joseph 55
Imperial Oil Limited 55
Exploration Surveys 55
Hibbart, Nick (10) 55

Johnson, Don R. (11) 55
Kasner, R.J. (12) 55
Lill, John R. (13) 56
History of the Prospectors Airways Co. Ltd. Prospect 59
Lynx–Canada Ltd. (14) 59
Maclean, D. (15) 62
McCharles, Harold (16) 62
New Goldvue Mines Occurrence (17) 62
Geophysical Surveys 62
Geological Survey 62
Diamond Drilling 63
Geology of the Property 63
N.W.T. Copper Mines Ltd. (18) 63
Area North of Marshall Lake 63
Area Around Lake "B" 64
Area South of Lake "A" 64
Saari, T. (19) 64
Stewart Lake Iron Mines of Ontario Ltd. (20) 64
History 64
Economic Potential of the Iron Deposit 64
Geology of the Property 65
Teck Corporation Ltd. (21) 65
History 65
Geology of the Property 66
Structural Geology of the Property 66
Description of the Deposit 66
Ternowesky, John (22) 67
Thorsteinson, David (23) 68
Weirmer, M. (24) 68
Recommendations for Future Exploration 68
References 69

TABLES

1. Table of Lithologic Units for the Little Marshall Lake Area 7
2. Field Numbers and Names of Chemically Analyzed and Thin–Sectioned Rocks, Little Marshall Lake Area 12
3. Chemical Analyses of Samples from the Little Marshall Lake Area 15
4. Modal Analyses of Lamprophyres, Gabbros and Diorites 30
5. Modal Analyses of the Summit Lake Stock 31
6. Modal Analyses of Diabase Dikes 32
7. Summary of Assay Results 40
8. List of Properties 43
9. Summary of K–Zone Drilling on Kendon Property 50
10. Estimate of Tonnage and Grade, 103 (Main) Zone 52
11. Summary of Diamond Drilling Results, Giant Gripp Mines Ltd.–Imperial Oil Limited, January–August 1977 57
12. Summary of Collar Intersections of Mineralization For Hole 154, by Imperial Oil Limited 59
13. Summary of Diamond Drilling Results, Rip Option of Prospectors Airways Co. Ltd. (1955) 61

FIGURES

1. Location of the Little Marshall Lake map area 4
2. Location of primary textures in metavolcanic rocks 8
3a. AFM plot of analyses of metavolcanic rocks 9
3b. Jensen (1976) cation plot of analyses of metavolcanic rocks 10
4. Location map of samples collected in the Little Marshall Lake area 11
5. General structure of the map area, showing the distribution of sulphide mineralization and kyanite-sillimanite occurrences 35
6. Property location map 44
7. Location of Jacobus Mining Corp. Ltd. drill program 47
8. Complete holdings of Kendon Copper Mines Ltd. acquired between 1966 and 1969 49
9. Location of Giant Gripp Mines Ltd.–Imperial Oil Limited drill program 56
10. Location of Prospectors Airways Co. Ltd. (Rip property) drill program 60
11. Location of Teck–Hughes Gold Mines Ltd. drill program about the main showing 65

PHOTOS

1. Tuff breccia to pyroclastic breccia, showing elliptical clasts of mafic, intermediate and felsic composition, in a sericitic matrix 22
2. Air-fall breccia consisting of large felsic blocks in a mafic matrix .. 23
3. Flattened and collapsed pumice fragments due to tectonic deformation 24
4. Tuff breccia in which elongate, tubular amygdules occur near the rim of several breccia fragments 25
5. Tuff breccia outcrop in which some broken breccia fragments can be fitted together to form larger, possibly original, fragments 25
6. Photomicrograph of sandstone showing relict sedimentary texture .. 28
7. Thinly bedded hornblende-feldspar-quartz gneiss within the metasedimentary unit north of Marshall Lake 29
8. Checkerboard feature probably produced by two strong fault-induced foliations 36
9. A photomicrograph of a polished section showing typical exsolution and intergrowth texture of chalcopyrite and sphalerite 42

MAP (back pocket)

Map 2531 (coloured) Little Marshall Lake area, scale 1:20 000.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.

Precambrian Geology
Little Marshall Lake Area

S.E. Amukun

Geologist, Precambrian Geology Section, Ontario Geological Survey.

Manuscript approved for publication by J. Wood, Chief Geologist, Ontario Geological Survey, June 5, 1985. Report published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The Little Marshall Lake area, which includes Summit, Gripp and Marshall lakes, is about 260 km² in size and is located some 255 km northeast of Thunder Bay. The area is readily accessible by float-equipped aircraft.

Interest in the exploration of the area was stimulated by the discovery of a base metal prospect by Teck–Hughes Gold Mines Ltd. (subsequently renamed Teck Corporation Ltd.) in the fall of 1954 and has continued to the time of writing. To date, 1 065 760 t of copper-zinc-silver mineralization has been outlined in one prospect.

Except for Proterozoic diabase dikes, all of the consolidated rocks underlying the map area are Archean in age, and consist of a metavolcanic-metasedimentary pile intruded by gabbroic and granitic rocks. The metavolcanic rocks constitute 80 percent of the map area and are a product of several volcanic centres defined by pumice dispersal areas and the distribution pattern of coarse-grained pyroclastic rocks. The metavolcanics are overlain conformably by volcaniclastic metasediments; these rocks have been intruded by semicircular bosses of gabbroic rocks and by the composite granitic Summit Lake stock.

The supracrustal rocks dip and face away from the granitic rocks. The major fold and fault structures of the map area are dominated by the Marshall Lake anticline, the Marshall Creek syncline and the Banana Lake and Gripp Lake faults. Other structural elements include: superimposed minor folds, complex crenulations, penetrative cleavage and axial planar foliations. Joints are ubiquitous in all of the rocks of the Little Marshall Lake area.

The rocks of the map area display some features that have been interpreted elsewhere as being characteristic of stratiform, massive, volcanogenic base metal sulphide deposits of the type usually associated with felsic volcanic rocks; the map area would therefore appear to be an attractive exploration target. In the iron formation in the northern part of the map area, the presence of approximately 35 million t of material grading 30 percent magnetite is indicated.

Precambrian geology, Little Marshall Lake area, by S.E. Amukun. Ontario Geological Survey, Report 267, 70p. Published 1989. ISBN 0–7729–5999–4.

Résumé

La zone de Little Marshall Lake, qui comprend les lacs Summit, Gripp et Marshall, a une superficie d'environ 260 km^2; elle est située à quelque 255 km au nord-est de Thunder Bay. La région est facilement accessible par hydravion.

C'est la découverte d'un gisement de métaux de base par Teck-Hughes Gold Mines Ltd. (dont la raison sociale est devenue depuis Teck Corporation) à l'automne 1954 qui a suscité l'intérêt pour cette région. Cet intérêt se poursuit encore aujourd'hui. Jusqu'ici, 1 065 760 tonnes de minéralisation en cuivre-zinc-argent ont été définies dans une même zone.

À l'exception des dykes de diabase protérozoïque, tout le substratum rocheux date de l'époque archéenne; il s'agit d'un amas métavolcanique-métasédimentaire pénétré par des gabbros et des roches granitiques. Les roches métavolcaniques représentent 80 p. 100 de la zone cartographiée; elles ont été produites par plusieurs centres volcaniques définis par des zones de dispersion de pierre ponce et par la répartition des roches pyroclastiques grossières. Les roches métavolcaniques sont recouvertes de métasédiments volcanoclastiques conformes; ces roches ont été pénétrées par des petits massifs intrusifs à contour semi-circulaire de roches gabbroïques, ainsi que par l'intrusion granitique à plusieur phases du lac Summit.

Le pendage et la polarité des roches supracrustales vont à l'opposé des roches granitiques. L'anticlinal du lac Marshall, le synclinal de la rivière Marshall et les failles du lac Banana et du lac Gripp forment les principlaes structures dans la zone cartographiée. Les autres éléments structuraux comprennent notamment des petits plis surimposés, des microplis complexes, une forte schistosité et des foliations axiales. Dans la région de Little Marchall Lake, les diaclases sont trés abondantes.

Des formations rocheuses présentent des caractéristiques que l'on retrouve dans les gisements de sulfures stratiformes massifs de type volcanogénique, qui sont généralement associés avec des roches volcaniques felsiques; il semblerait donc que la zone cartographiée constitue une région prometteuse pour l'exploration. Dans la formation de fer de la partie nord de la carte, on a relevé la présence d'environ 35 millions de tonnes de matière contenant 30 p. 100 de magnétite.

Precambrian geology, Little Marshall Lake area, by S.E. Amukun. Ontario Geological Survey, Report 267, 70p. Published 1989. ISBN 0-7729-5999-4.

Introduction

LOCATION AND ACCESS

The map area covers Gripp and Marshall lakes, which are located approximately 30 km northeast of the village of Auden, on the Canadian National Railway transcontinental line. The centre of the area lies some 255 km northeast of the city of Thunder Bay (Figure 1).

The area is contained within latitudes 50°22'30" to 50°30'00"N and longitudes 87°30'00" to 87°45'00"W, and covers approximately 260 km².

The Little Marshall Lake area is accessible only by float-equipped aircraft which can be chartered from Jellicoe, Geraldton or Nakina. In the winter, the western part of the map area can be reached by a 21 km road which starts at Toronto Lake from the extension of Auden Road. Auden Road is the northern extension of Highway 801 (from the Namewaminikan River) and is maintained by the Ministry of Natural Resources.

Some of the waterways in the area, including the Marshall–Gripp–Summit lakes system, Marshall Creek, and the Ombabika and Powitik rivers, are navigable at high water levels. Several waterfalls obstruct the courses of the Powitik and Gripp rivers and are indicated on Map 2531 (back pocket).

Marshall Lake is drained to the south by Marshall Creek and to the west by the Gripp River which also drains the waters of Gripp Lake and discharges into Summit Lake. Summit Lake is unusual because it lies between two drainage basins, draining to the north (Powitik River) and to the south (Ombabika River), and is only about 2.4 m deep.

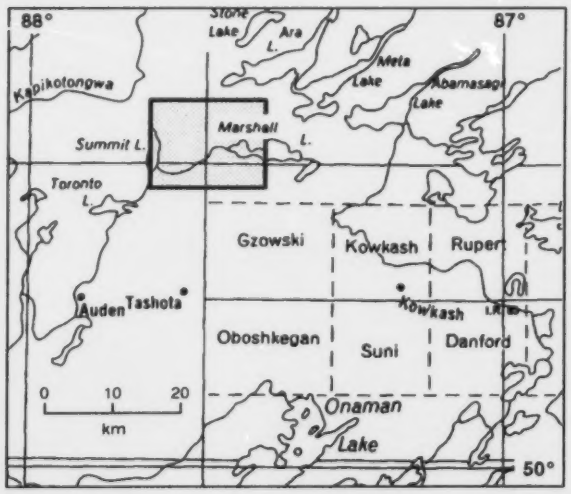

Figure 1. *Location of the Little Marshall Lake map area.*

MINERAL EXPLORATION

The initial mining activity of the map area was triggered by the discovery of copper-zinc mineralization by prospectors of Teck–Hughes Gold Mines Ltd. (now Teck Corporation Ltd.) in the fall of 1954, about 1.6 km south of Gripp Lake (Langford 1959). In the ensuing staking rush, most of the Gripp Lake–Marshall Lake area was staked.

In the winter of 1954–1955, Teck–Hughes Gold Mines Ltd. put down 20 diamond-drill holes (numbered 1 to 20) for a total length of 2557 m. The company also carried out exploration work, including trenching, ground and airborne electromagnetic (EM) and magnetic (MAG) surveys, and geological mapping. In 1961, an additional 12 diamond-drill holes (numbered 21 to 32) totalling 1420 m in length were collared. In 1971, MAG, self potential (SP) and very low frequency electromagnetic (VLF–EM) surveys were also completed on the "Teck Showing".

Following the staking rush, the Billiton Company excavated trenches which exposed copper-zinc mineralization south of the western end of Marshall Lake (Langford 1959). Several owners have since acquired the "Billiton Showing" and have performed the following:

1. In 1962, Jacobus Mining Corp. Ltd. hired Sheridan Geophysics Ltd. to conduct geophysical surveys: following this, extensive diamond drilling totalling over 3000 m in length was completed.
2. In 1963 and 1967 Marshall Lake Mines Ltd. (with G. Reid) conducted diamond drilling in which two and four holes totalling 105 and 610 m in length, respectively, were collared. By 1968, the "Billiton Showing" had come under two separate ownerships (Bayne 1970).
3. Kendon Copper Mines Ltd. acquired the claims west of and including the leased claim KK23033 (presently TB346422). In the spring of 1968, an induced polarization (IP) survey was completed on part of the Kendon property. Between August 1968 and July 1970, over 50 diamond-drill holes totalling over 3600 m in length, designated according to the zone numbers, were completed on the D, S, B, N, K, M (the "Billiton Showing"), J and F zones by Kendon Copper Mines Ltd. The core recovered from three diamond-drill holes (MT series) was used for mill test purposes. Exploration up to November 1969 indicated estimated reserves at the Kendon property of 242 000 t averaging 1.45 percent copper, 4.76 percent zinc and 2.8 ounces per ton silver (D.W. Sullivan, 1970, Assessment Files Research Office, Ontario Geological Survey, Toronto (AFRO)).

4. N.W.T. Copper Mines Ltd. held the ground east of KK23033. In 1968 and 1969, this company conducted additional geophysical surveys on the "Billiton Showing". Diamond drilling, totalling 2461 m in length was put down on the eastern extension of the Main (M) zone of Kendon Copper Mines Ltd.; 723.2 m of preliminary testing of five other mineralized zones (Bayne 1970, p.iii) was carried out as well. In 1970, a feasibility study of the main zone of N.W.T. Copper Mines Ltd. was conducted by the consulting engineering firm of A.S. Bayne and Company. The company described an area of indicated and inferred mineralization east of claim KK23033 amounting to 1 065 760 t to a depth of 300 m grading 0.82 percent copper, 2.71 percent zinc, 1.77 ounces silver per ton and trace amounts of gold (Bayne 1970, p.iii).
5. By 1973, N.W.T. Copper Mines Ltd. had acquired the Kendon Copper Mines property and hence the entire strike length of the Billiton showing. In 1973, St. Joseph Explorations Ltd. optioned 45 leased and 21 unleased claims of N.W.T. Copper Mines Ltd., which were then transferred to a new holding company, Giant Gripp Mines Inc. The exploration surveys conducted by St. Joseph Explorations Ltd. included MAG, horizontal loop electromagnetic (HLEF) and VLF–EM surveys, and a total of 11 diamond-drill holes.
6. In October 1975, Imperial Oil Limited entered into an option agreement with Giant Gripp Mines Inc. and Teck Corporation Ltd. to investigate a large block of claims in the Gripp Lake–Marshall Lake area including the original Billiton and Teck prospects. In the summer of 1976, several surveys including IP work, detailed geological mapping and rock trenching were conducted. In 1977, Imperial Oil Limited conducted additional geophysical and geological surveys and diamond drilling. Exploration work was continuing at the time this report was written.

Other exploration conducted in the map area following the original Teck discovery was done by the following:

1. In 1952, Kennco Explorations (Canada) Ltd. conducted an airborne electromagnetic (AEM) and MAG survey on a larger area that included all of the map area.
2. In 1955, Consolidated Marbenor Mines Ltd. drilled four diamond-drill holes, totalling 678 m in length on the eastern shore of Summit Lake and intersected minor amounts of gold and copper.
3. In 1955, New Goldvue Mines Ltd. and Prospectors Airways Co. Ltd. (Property No. 13, *see* Table 8) conducted a geophysical survey (MAG, EM) in the Little Marshall Lake area, following which each company collared diamond-drill holes (eight for 764 m and eight for 917 m, respectively) and found iron formation and graphite.
4. In 1955, a resistivity survey was conducted for Callinan Flin–Flon Mines Ltd. (Property No. 14), Alator Corporation Ltd. (Property No. 8), Yellowknife Bear Mines Ltd. and Silver–Miller Mines Ltd. No further work was reported.
5. In the late 1950s, Panther International Mining Company Ltd. tested magnetic iron formation anomalies in the northwestern part of the map area with three diamond-drill holes totalling 308 m in length. Their claims were acquired by Stewart Lake Iron Mines of Ontario Ltd., who continued diamond drilling and geophysical surveys in 1959 (1107 m) and 1962 (323 m). Eleven diamond-drill holes were put down, totalling 1382 m in length, and were completed by 1962. Calculations based on diamond drilling carried out in 1959 indicated probable reserves of 35 million t of material containing 30 percent magnetite to a depth of 300 m (Newman, 1962, AFRO).

In the 1960s and 1970s, several individuals conducted exploration work on parts of the map area. In 1965, V. Feeley collared seven diamond-drill holes (total length of 302 m) on the eastern border of the map area north and south of Marshall Lake. F. Koosel conducted MAG, EM and rock trenching in the area north of Little Marshall Lake and south of Lake "B" (informal name, *see* legend footnote "g", Map 2531) in 1971. R. Pelky put down two diamond-drill holes totalling 152 m in length for C. Gonzales in 1973.

New activity conducted in the map area during the 1977 field season included prospecting, rock trenching, geological mapping, ground geophysics and diamond drilling by employees of Imperial Oil Limited. Prospecting and rock trenching were also performed by various individual prospectors on their claims in the Gripp Lake area. Additional staking in the map area in 1977 was conducted in the area south and west of Phillips Lake after the completion of the field component of this report.

At the time of writing, field crews of Imperial Oil Limited were conducting follow-up and new diamond drilling on the "Teck" and "Giant Gripp" properties. This work was planned to continue.

PREVIOUS GEOLOGICAL STUDIES

According to Langford (1959), P.E. Hopkins examined the Marshall Lake area in 1915 and 1916 and proposed the name "Marshall Lake Series" for the rocks around Marshall Lake. In 1929 and 1930, a much larger area including the whole of the map area was covered by the reconnaissance mapping of Kindle (1931).

As a result of a staking rush caused by the discovery of a chalcopyrite showing south of Gripp

Lake by Teck–Hughes Gold Mines Ltd. (now Teck Corporation Ltd.) in the fall of 1954, the Gripp Lake area was mapped for the Ontario Department of Mines by Langford (1959). The southern half of the map area was included in Langford's study.

Some of the rock units outlined by the detailed mapping of the eastern half (northern part) of the Crescent Lake area immediately to the west (Pye 1968) and the northern part of the Willet Lake area immediately to the south (Amukun *et al.* 1976; Amukun 1977b) extend into the map area.

Several brief summaries of the geology of individual or a group of properties are presented in geological and/or geophysical reports of various companies as filed for assessment credit (Assessment Files Research Office, Ontario Geological Survey, Toronto, (AFRO); Resident Geologist's Files, Ministry of Northern Development and Mines, Thunder Bay and Beardmore–Geraldton).

The generalized geology of the map area is available on a 1 inch to 4 mile (1:253 440) compilation map published by the Ontario Department of Mines (Pye *et al.* 1965). Aeromagnetic maps are also available at a scale of 1 inch to 1 mile (1:63 360) and 1 inch to 4 miles (1:253 440) (ODM–GSC 1963a, 1963b, 1965).

PRESENT GEOLOGICAL SURVEY

Geological mapping was conducted by the author and his assistants between May 25 and September 4, 1977, and a preliminary map (P.1561) at a scale of 1 inch to 1/4 mile (1:15 840) was issued in 1978 (Amukun *et al.* 1978); an updated and coloured version of this map, Map 2531, is included in the back pocket of this report. The field map was prepared at a scale of 1 inch to 1/4 mile (1:15 840) on cronaflex base maps prepared by the Cartography Section, Surveys and Mapping Branch, Lands and Waters Group, Ontario Ministry of Natural Resources. The geological data were plotted in the field on acetate overlays of aerial photographs at the same scale as the base maps. Traverses were planned to cross the regional strike of the rocks, at 350 m intervals, and at right angles wherever possible, and between distinct topographic features such as lakes, rivers, trails, eskers and surveyed lines where possible. Traverses were planned to examine most of the outcrops spotted on aerial photographs. Some interpretation of outcrops, linear features and extensions of diabase dikes that were not actually observed or examined in the field, however, was done using the aerial photographs. Minor topographic revisions were made on the base map during the survey.

Samples of all of the granitic rocks were stained in the field. Selected typical and atypical specimens were chemically analyzed by rapid methods at the Geoscience Laboratories of the Ontario Geological Survey, Toronto. Numerous selected rock samples were thin sectioned for microscopic studies.

ACKNOWLEDGMENTS

Capable assistance was received from J.R. Foster who, as senior assistant, was responsible for independent mapping of approximately half of the area, including the area around Gripp and Summit lakes. J.A. MacDonald, M. Johnson and J. Parker served as junior assistants. J.A. MacDonald was responsible for some independent mapping. The author is grateful for information and assistance provided by Imperial Oil Limited and N.W.T. Copper Mines Ltd. during the field survey. Logistic aid was provided by K.G. Fenwick in his former capacity as Regional Geologist, Thunder Bay, and by J. Scott, formerly Resource Geologist, Thunder Bay, who contributed to the photographic illustrations included in this report. Informative discussions with colleagues of the author, particularly W.O. Mackasey and J. Wood, were particularly helpful. Finally, the author acknowledges the air support and supply services provided by several proprietors of the settlement of Jellicoe.

General Geology

The Little Marshall Lake area is near the northern boundary of that part of the Wabigoon metavolcanic-metasedimentary belt east of Lake Nipigon (Mackasey *et al.* 1974). The consolidated rocks of the map area, except for Proterozoic diabase dikes, are of Archean age, and consist of metavolcanic and metasedimentary rocks intruded by dikes and sills composed of intermediate to mafic intrusive rocks, and by stocks, dikes and sills of intermediate to felsic igneous rocks (*see* Table 1 for lithologic units).

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE LITTLE MARSHALL LAKE AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

RECENT

Alluvial, peat, bog and swamp deposits.

PLEISTOCENE

Moraine, esker and outwash deposits.

UNCONFORMITY

PRECAMBRIAN

PROTEROZOIC

MAFIC INTRUSIVE ROCKS

Diabase, porphyritic diabase.

INTRUSIVE CONTACT

ARCHEAN

METAMORPHOSED FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

Pegmatite, aplite, felsite, granite dikes.

INTRUSIVE CONTACT

Quartz–feldspar porphyry, quartz diorite, trondhjemite, diorite, quartz monzonite[1].

INTRUSIVE CONTACT

METAMORPHOSED INTERMEDIATE TO MAFIC INTRUSIVE ROCKS

Gabbro, hornblende gabbro, hornblende schist, amphibolite[2], mafic dike, diorite, quartz-bearing diorite, lamprophyre.

INTRUSIVE CONTACT

METASEDIMENTS

CLASTIC METASEDIMENTS

Mudstones (slate, argillite), sandstones, pebbly sandstone, hornblende-feldspar-quartz schist or gneiss, mica schist or gneiss, chlorite schist, laminated hornblende schist (amphibolite), reworked tuff.

CHEMICAL METASEDIMENTS

Iron formation, chert, feruginous chert.

METAVOLCANICS

INTERMEDIATE TO FELSIC METAVOLCANICS

Flows: pillowed flows, flow breccia–pillow breccia, porphyritic flows (feldspar porphyry), spherulitic and/or variolitic flows, amygdaloidal/vesicular flows.

Pyroclastic rocks: tuff to lapilli tuff, banded tuff, lapillistone, lapilli tuff, tuff breccia to pyroclastic breccia, pumiceous pyroclastic rocks (ash flows), crystal tuff, air-fall breccia, unsubdivided volcanic breccia.

Intrusive volcanic rocks: quartz and/or feldspar porphyry, felsic dike.

Metamorphic volcanic rocks: sericite schist, mica schist, chlorite schist, amphibolite schist or gneiss, chlorite schist, amphibolite schist or gneiss, gneissic metavolcanics, garnetiferous metavolcanics.

MAFIC TO INTERMEDIATE METAVOLCANICS

Flows: pillowed flows, coarse-grained flows, flow breccia, coarse-grained (hornblende-rich) rocks; chlorite schist, quartz and/or feldspar porphyry, garnetiferous metavolcanics.

[1]*Summit Lake stock*

[2]*Little Marshall Lake and Marshall Lake intrusions*

Unconsolidated Pleistocene and Recent deposits cover a large amount of the surface of the map area.

The regional metamorphic rank to which the rocks have been subjected ranges from the chlorite to biotite zones of the greenschist facies (Turner 1968). However, local "hot-spots" equivalent to lower amphibolite facies conditions occur. These local zones may represent metasomatic alteration zones.

The metavolcanics and metasediments in general dip and face away from the granitic stock located in the core of a large regional anticlinal structure which has been interpreted to cross the centre of the map area. An associated smaller, tight synclinal structure has also been interpreted near the southern border of the map area. Several superimposed folding features in the form of minor antiform-synform fold pairs, drag folds, chevron folds and very complex crenulations were also recognized by the author. These features have lineation and plunge attitudes similar to the major folds, and in many cases control the distribution of base metal sulphide mineralization.

Aeromagnetic maps are fairly useful in extrapolating geology, since the iron formation and ferruginous metasedimentary units display a magnetic effect which can be traced around the perimeter of the major folds.

ARCHEAN

METAVOLCANICS

The metavolcanics underlie 80 percent of the map area, and are made up of mafic to intermediate and intermediate to felsic varieties. Most of the original textures of the metavolcanics have been altered by deformation, cataclasis and metamorphism.

Based on the distribution of pumice fall deposits and coarse-grained pyroclastic rocks (Figure 2), the metavolcanic pile is probably a product of several centres of volcanism. The presence of discontinuous stratiform and graded argillite and sandstone beds, commonly associated with ferruginous chert layers, together with pillowed flows, implies a submarine depositional environment. Submarine and/or subaerial pyroclastic episodes probably produced bedded tuffs and local lenses of coarse breccias near

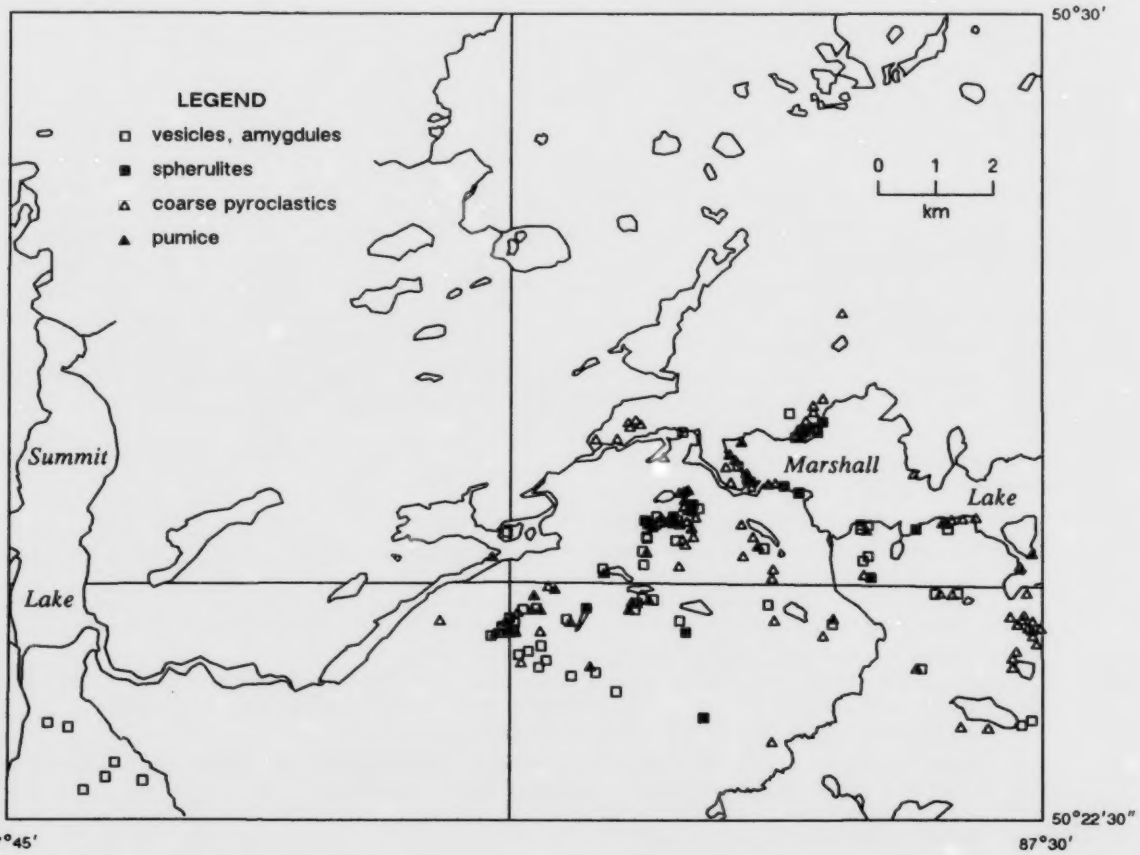

Figure 2. *Location of primary textures in metavolcanic rocks.*

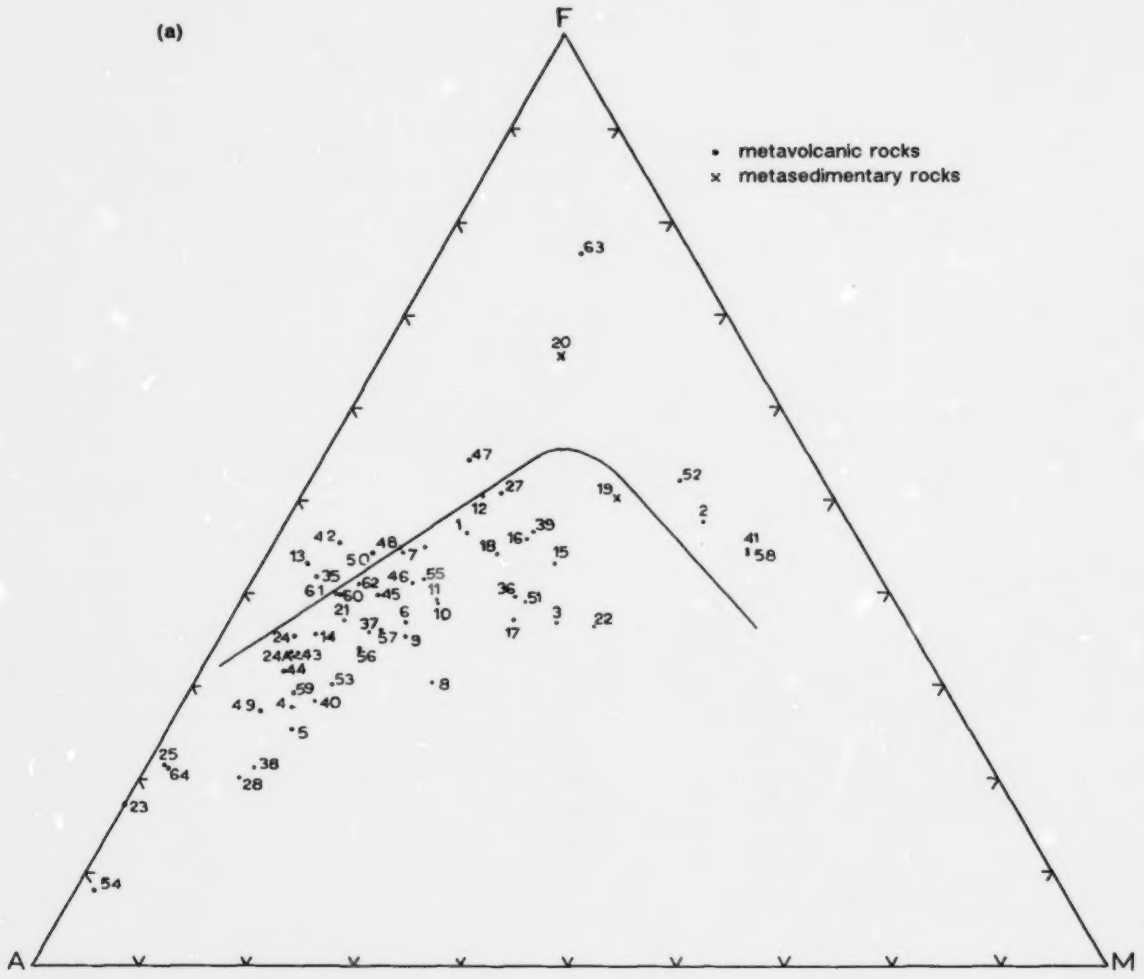

Figure 3a. *AFM plot of analyses of metavolcanic rocks. See Table 2 and Figure 4 for sample number key and sample locations, respectively.*

eruptive centres. Ash flows are recognized only by the presence of pumice fragments and highly vesicular rocks. The metavolcanics are divisible into a tholeiitic (mafic to intermediate) and a calc-alkalic (felsic to intermediate) suite as defined by Irvine and Baragar (1971) and more recently by Jensen (1976). Ternary plots are given in Figures 3a and 3b and sample locations are shown in Figure 4.

Mafic To Intermediate Metavolcanics

These rocks range in composition from basalt to andesite, and have a predominantly tholeiitic affinity (Figure 3b, Table 2: samples 20 and 41). In the map area, the mafic metavolcanic rocks make up only 5 percent of the metavolcanic rocks and are exposed in only one large outcrop, representing a unit about 610 to 914 m wide, east and northeast of Little Marshall Lake. Other minor outcrops of mafic to intermediate metavolcanics are, however, scattered throughout the intermediate to felsic metavolcanic units, particularly in the area southeast of Gripp Lake, as unmappable parts within these units. The mafic to intermediate metavolcanics are made up of four subdivisions which are outlined below.

FLOWS

Almost all the lavas are pillowed, retaining oblong pillow structures of varied sizes. In most of these pillow structures, deformation has obliterated the original size and shape, such that a top determination is unreliable. In some of the pillows, the core is light grey and consists of visible plagioclase, epidote and chlorite. Thin section study reveals that the selvage is composed of chlorite, epidote, quartz, calcite and zoisite.

Porphyritic flows are uncommon; where observed, these flows are composed of anhedral to

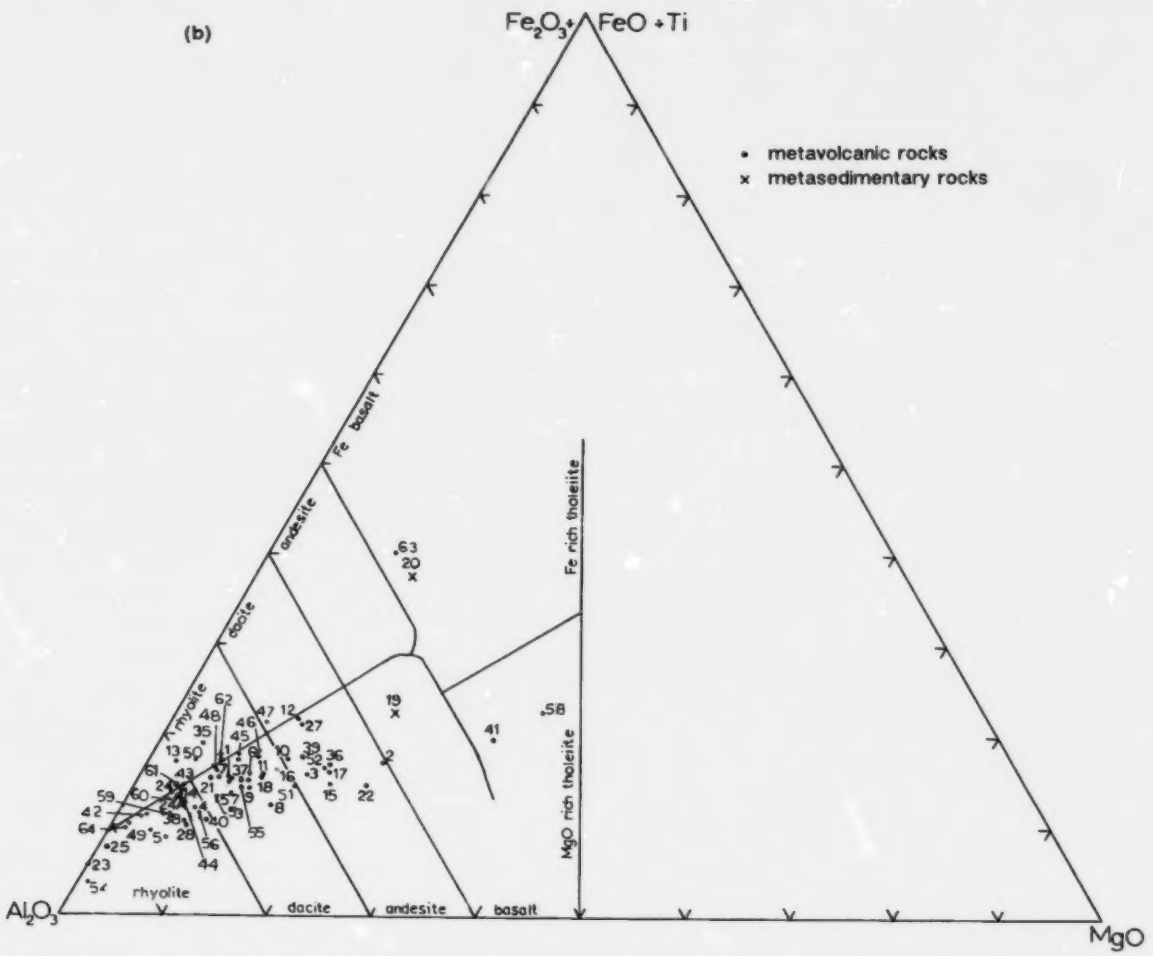

Figure 3b. *Jensen (1976) cation plot of analyses of metavolcanic rocks. See Table 2 and Figure 4 for sample number key and sample locations, respectively.*

subhedral metacrysts of altered feldspar. These rocks are hard to distinguish from porphyritic intrusive rocks of the same composition both in the field and in the laboratory where other diagnostic flow textures and structures are absent. The most reliable criteria used to distinguish these rocks may be the intrusive features observed in the field, such as chilled borders, crosscutting relationships, flow layering, sudden grain size and textural changes, and very rarely, the presence of xenoliths in the intrusive rock.

Coarse-grained flows are also recognized with difficulty without diagnostic flow features such as variolites, amygdules, pillows and epidotized cores, in view of the modification of original textures by recrystallization and deformation. In most of the mafic to intermediate flows, tuffs and gabbroic rocks, increase in grain size is accompanied by an increase in secondary hornblende or actinolite-tremolite. In very coarse-grained types, these ferromagnesian minerals can form up to 80 percent of these rocks. The distinction of the coarse-grained flows from mafic intrusive rocks can only be accomplished by observations of relative age relationships in the field.

In the field, a typical pillowed lava sample is grey-green to dark green to shades of grey and black, independent of mineralogy, and is dominantly chloritic or hornblendic and feldspathic in composition. The less altered flows are composed of hornblende, sodic plagioclase (albite), chlorite, biotite, clinozoisite, carbonate, epidote, sphene, quartz and magnetite (*see* Table 3 and Figures 3a, 3b: samples 27, 41 and 58).

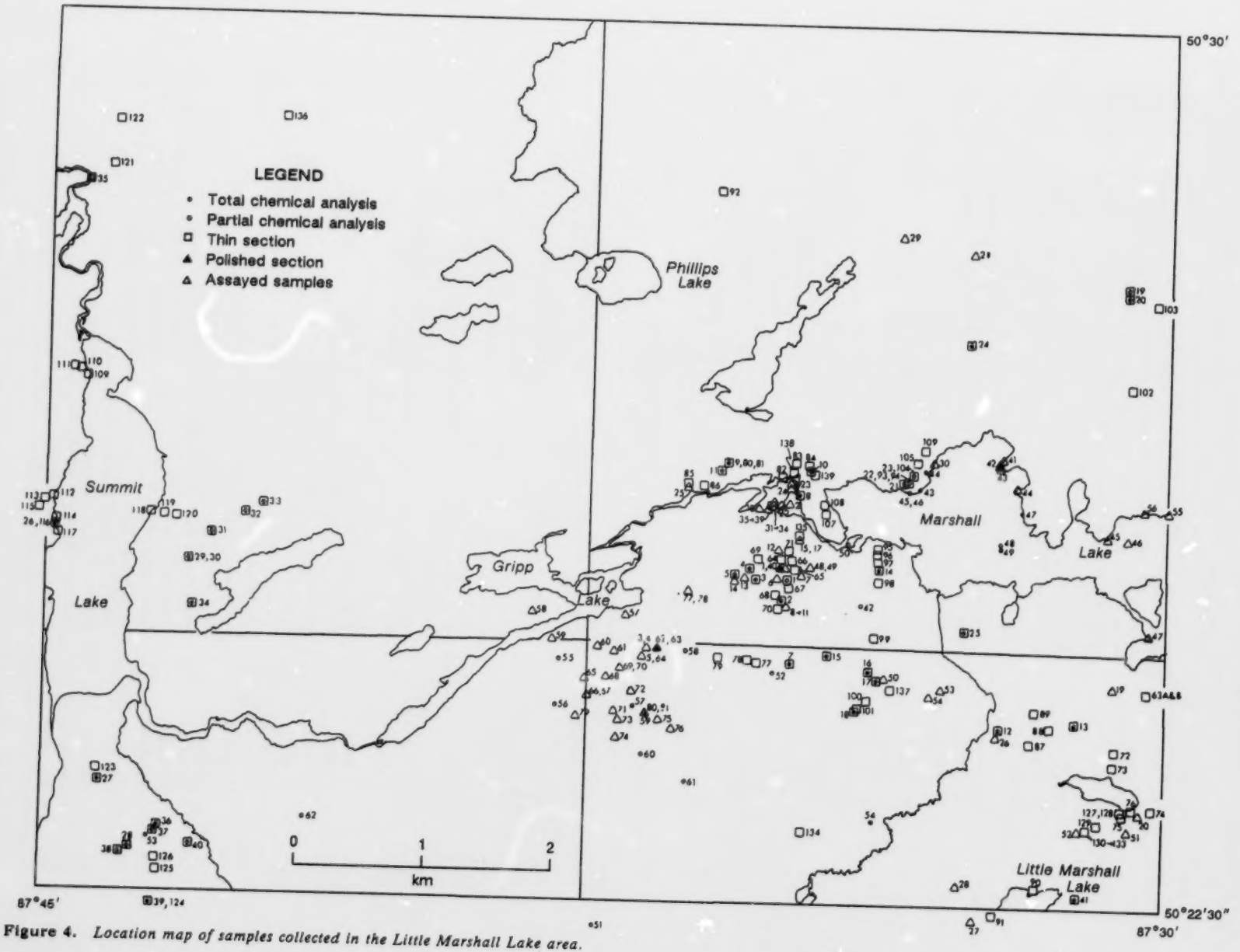

Figure 4. *Location map of samples collected in the Little Marshall Lake area.*

TABLE 2. FIELD NUMBERS AND NAMES OF CHEMICALLY ANALYZED AND THIN-SECTIONED ROCKS, LITTLE MARSHALL LAKE AREA.

Code No.[1]	Field Sample No.	Field Name	Laboratory Classification[2]	Analysis Type[3]
1	7A-010-1	intermediate to felsic lapilli tuff	calc-alkalic dacite	P, T.S.
2	7A-014-1	felsic lapilli tuff	calc-alkalic andesite	W, T.S.
3	7A-022-1	intermed. to felsic lapilli tuff	calc-alkalic andesite	W, T.S.
4	7A-023-1	felsic lapilli tuff	calc-alkalic rhyolite	W, T.S.
5	7A-025-1	rhyolite porphyry	calc-alkalic rhyolite	W, T.S.
6	7A-040-1	intermed. to felsic lapilli tuff	calc-alkalic dacite	P, T.S.
7	7A-090-1	rhyolite	calc-alkalic dacite	W, T.S.
8	7A-098-1	felsic tuff	calc-alkalic dacite	P, T.S.
9	7A-101-3	matrix of felsic lapilli tuff, tuff breccia	calc-alkalic dacite	W, T.S.
10	7A-108-1	intermed. to felsic tuff	calc-alkalic andesite	P, T.S.
11	7A-113-1	intermed. to felsic tuff breccia	calc-alkalic dacite	P, T.S.
12	7A-119-1	lithic tuff	tholeiitic dacite	W, T.S.
13	7A-128-1	intermed. to felsic	tholeiitic rhyolite	W, T.S.
14	7A-506-1	intermed. to felsic tuff	calc-alkalic rhyolite	W, T.S.
15	7A-516	intermed. lapilli tuff	calc-alkalic andesite	W, T.S.
16	7A-528	intermed. lapilli tuff	calc-alkalic dacite	W, T.S.
17	7A-530-1	intermed. to felsic tuff breccia	calc-alkalic andesite	W, T.S.
18	7A-535	intermed. to felsic tuff	calc-alkalic dacite	W, T.S.
19	7A-542-2	amphibolite metasediments	calc-alkalic basalt	P, T.S.
20	7A-543	garnet-hornblende schist (metasediments)	tholeiitic basalt	W, T.S.
21	7A-548-1	intermed. to felsic crystal tuff	calc-alkalic dacite	P, T.S.
22	7A-549-1	intermed. to felsic lapilli tuff	calc-alkalic andesite	P, T.S.
23	7A-551-2	quartz-feldspar porphyry	calc-alkalic rhyolite	P, T.S.
24	7A-557-1	felsic lapilli tuff	tholeiitic rhyolite	W, T.S.
25	7A-574-2	quartz-rhyolite porphyry	calc-alkalic rhyolite	W, T.S.
26	7A-585-2	quartz diorite /trondhjemite		P, T.S.
27	7A-596-1	mafic tuff	calc-alkalic andesine	W, T.S.
28	7A-601-2	quartz-feldspar porphyry	calc-alkalic rhyolite	P, T.S.
29	7A-603-1	quartz monzonite		P, T.S.
30	7A-603-2	diorite		P, T.S.
31	7A-604-1	quartz diorite		P, T.S.
32	7A-605	quartz diorite		P, T.S.
33	7A-606-1	quartz diorite		P, T.S.
34	7A-607-1	porphyritic diorite		P, T.S.
35	7A-610-1	intermed. to felsic tuff	tholeiitic rhyolite	P, T.S.
36	7A-611-1	felsic tuff	calc-alkalic andesite	W, T.S.
37	7A-612-1	intermed. to felsic crystal tuff	calc-alkalic dacite	P, T.S.
38	7A-613-1	felsic lapilli tuff	calc-alkalic rhyolite	P, T.S.
39	7A-614-1	felsic lapilli tuff	calc-alkalic andesite	W, T.S.
40	7A-617-1	intermed. to felsic tuff/porphyritic flow	calc-alkalic rhyolite	P, T.S.
41	7A-629-1	metabasalt	tholeiitic basalt	W
42	7A-093-2	vesicular bomb from lapilli tuff		P
43	7A-158-3	intermed. to felsic ash flow		P

TABLE 2. Continued

Code No.[1]	Field Sample No.	Field Name	Laboratory Classification[2]	Analysis Type[3]
44	7A-174-1	intermed. to felsic pillowed flow		P
45	7A-187-1	intermed. to felsic porphyritic flow		P
46	7A-187-3	intermed. to felsic pillowed flow		P
47	7A-200	intermed. to felsic flow breccia		P
48	7A-204-1	intermed. to felsic metavolcanic		P
49	7A-205-1	flow		P
50	7A-231	flow		P
51	7A-270-2	quartz-feldspar porphyry		P
52	7A-281	intermed. to felsic lapilli tuff		P
53	7A-599-1	felsic lapilli tuff		P
54	7A-649-1	felsic tuff breccia		P
55	7A-724-1	felsic tuff		P
56	7A-738	felsic tuff		P
57	7A-776	intermed. to felsic tuff		P
58	7A-784-2	mafic flow breccia		P
59	7A-788	intermed. to felsic tuff		P
60	7A-803	quartz-feldspar porphyry		P
61	7A-820	felsic volcanic? sediment?		P
62	7A-877	intermed. to felsic tuff		P
63A	7A-1003M	matrix from air-fall breccia		P
63B	7A-1003F	fragment from air-fall breccia		P
64	7A-000-3	air-fall breccia		T.S.
65	7A-008-2	diabase		T.S.
66	7A-009-2	intermed. to felsic porphyry		T.S.
67	7A-012-1	lamprophyre		T.S.
68	7A-015-1	lamprophyre		T.S.
69	7A-019-1	intermed. tuff		T.S.
70	7A-031-2	diabase		T.S.
71	7A-048-1	intermed. tuff		T.S.
72	7A-061-1	tuff		T.S.
73	7A-062-1	lithic tuff		T.S.
74	7A-066-1	fault breccia		T.S.
75	7A-068-1	metaslate		T.S.
76	7A-069-1	diorite		T.S.
77	7A-075-1	fault breccia		T.S.
78	7A-076-1	intermed. to felsic lapilli tuff		T.S.
79	7A-080-2	diabase		T.S.
80	7A-101-2	pyroclastic bomb		T.S.
81	7A-101-3	matrix of felsic lapilli tuff, tuff breccia		T.S., W
82	7A-104-2	lapilli tuff		T.S.
83	7A-106-1	sheared intermed. to felsic tuff		T.S.
84	7A-107-2	diabase		T.S.
85	7A-109-2	lithic tuff		T.S.
86	7A-111-1	intermed. to felsic tuff breccia		T.S.
87	7A-122-2	lithic tuff		T.S.
88	7A-127-1	intermed. to felsic lithic tuff		T.S.
89	7A-130-1	intermed. to felsic tuff		T.S.
90	7A-133-1	gabbro		T.S.
91	7A-137-2	gabbro		T.S.
92	7A-155-1	hornblende schist		T.S.
93	7A-164-1	intermed. to felsic pillowed flow		T.S.
94	7A-164-2	intermed. to felsic spherulitic flow		T.S.
95	7A-502	intermed. lapilli tuff		T.S.
96	7A-503	intermed. tuff breccia		T.S.

TABLE 2. Continued

Code No.[1]	Field Sample No.	Field Name	Laboratory Classification[2]	Analysis Type[3]
97	7A-505-3	quartz-feldspar porphyry		T.S.
98	7A-509	intermed. to felsic tuff		T.S.
99	7A-524-2	intermed. lapilli tuff		T.S.
100	7A-533	felsic tuff		T.S.
101	7A-534	intermed. to felsic tuff		T.S.
102	7A-539	biotite schist		T.S.
103	7A-541	amphibolite		T.S.
104	7A-551-1	felsic spherulitic volcanic		T.S.
105	7A-552-2	hornblende gabbro		T.S.
106	7A-554-1	intermed. to felsic tuff breccia		T.S.
107	7A-568	hornblende gabbro		T.S.
108	7A-569-1	intermed. to lithic tuff		T.S.
109	7A-577-1	porphyritic quartz diorite		T.S.
110	7A-578	trondhjemite gneiss		T.S.
111	7A-579-1	quartz-feldspar porphyry		T.S.
112	7A-581-1	quartz diorite/trondhjemite		T.S.
113	7A-582-1	quartz diorite		T.S.
114	7A-583-1	quartz diorite		T.S.
115	7A-584-2	quartz diorite		T.S.
116	7A-585-1	diorite		T.S.
117	7A-586-1	quartz diorite/trondhjemite		T.S.
118	7A-587	quartz diorite		T.S.
119	7A-588-1	quartz diorite/trondhjemite		T.S.
120	7A-589-1	quartz diorite		T.S.
121	7A-590-1	intermed. tuff		T.S.
122	7A-592-1	amphibole schist		T.S.
123	7A-595-1	rhyolite tuff		T.S.
124	7A-614-1	diabase		T.S.
125	7A-615	porphyrytic diabase		T.S.
126	7A-616-2	porphyritic diabase		T.S.
127	7A-624-1	air-fall breccia		T.S.
128	7A-624-2	ferruginous chert		T.S.
129	7A-627-2	garnet-hornblende schist		T.S.
130	7A-628-1			T.S.
131	7A-628-2	hornblende gabbro		T.S.
132	7A-628-3	garnet-hornblende schist		T.S.
133	7A-628-4	hornblende schist		T.S.
134	7A-651-2	rhyolite		T.S.
135	7A-033-1	sericite schist derived from intermed. tuff		T.S.
136	7A-609-1	garnet-hornblende schist		T.S.
137	7A-532-2	intermed. lapilli tuff		T.S.
138	7A-561-2	intermed. tuff		T.S.
139	7A-108-1	sheared and deformed tuff		T.S.

1. Number used in Figures 3a, 3b, 4
2. After L.S. Jensen (1976).
3. P = partial analysis, W = complete whole rock analysis, T.S. = thin section

TABLE 3. CHEMICAL ANALYSES OF SAMPLES FROM THE LITTLE MARSHALL LAKE AREA.

	intermediate to mafic metavolcanics			intermediate to felsic tuffs		
Map No.	27	41	58	8	10	12
Sample No.	7A-596-1	7A-629-1	7A-784-2	7A-098-1	7A-108-17	7A-119-1
SiO_2	63.3	54.9	47.9	68.5	65.8	64.0
Al_2O_3	15.7	14.7	14.5	15.3	15.3	15.2
Fe_2O_3†	1.92	1.28	11.0	3.56	5.4	1.90
FeO	4.82	6.45	–	–	–	4.74
MgO	2.40	7.57	9.70	2.34	2.31	2.18
CaO	5.16	11.1	7.09	2.88	3.43	4.45
Na_2O	2.22	1.71	1.51	3.19	3.96	2.51
K_2O	1.71	0.10	0.85	1.80	1.35	1.62
H_2O^+‡	0.97	0.55	5.30	1.4	1.0	1.52
H_2O^-	0.52	0.18	–	–	–	0.47
CO_2	0.32	0.23	–	–	–	1.01
TiO_2	0.57	0.61	1.00	0.40	0.62	0.70
P_2O_5	0.15	0.06	0.54	0.11	0.19	0.19
S	0.01	<0.01	–	–	–	<0.01
MnO	0.11	0.17	0.18	0.07	0.08	0.11
total	99.9	99.7	99.6	99.6	99.4	100.6
specific gravity	2.81	2.93	2.70	2.68	2.72	2.79
Ba	330	70				160
Co	15	45				15
Cr	90	340				50
Cu	20	60				35
Li	10	4				15
Ni	65	35				40
Pb	<10	<10				10
Zn	100	65				110

	intermediate to felsic tuffs					
Map No.	13	14	18	21	35	36
Sample No.	7A-128-1	7A-506-1	7A-535	7A-548-1	7A-610-1	7A-611-1
SiO_2	67.4	69.0	68.4	67.0	64.4	64.6
Al_2O_3	17.3	16.5	15.1	15.5	16.2	13.7
Fe_2O_3†	0.98	0.86	0.69	4.21	5.76	0.75
FeO	3.78	2.45	3.41	–	–	3.85
MgO	0.45	0.80	1.95	1.10	0.71	2.87
CaO	1.97	2.90	4.59	3.9	3.21	5.98
Na_2O	3.76	3.06	1.88	3.89	5.24	2.81
K_2O	1.89	1.94	1.22	1.44	1.27	1.16
H_2O^+‡	0.77	0.62	1.13	1.6	1.7	0.93
H_2O^-	0.56	0.63	0.60	–	–	0.50
CO_2	0.37	0.55	0.60	–	–	2.54
TiO_2	0.56	0.68	0.50	0.50	0.51	0.47
P_2O_5	0.11	0.18	0.11	0.13	0.14	0.14
S	0.02	0.01	0.05	–	–	0.03
MnO	0.17	0.06	0.05	0.06	0.21	0.15
total	100.1	100.1	100.3	99.3	99.4	100.5
specific gravity	2.72	2.70	2.74	2.68	2.73	2.70
Ba	270	310	160			160
Co	10	15	15			7
Cr	35	65	75			45
Cu	8	30	35			20
Li	9	20	10			7
Ni	20	45	45			25
Pb	10	15	<10			10
Zn	45	50	25			45

TABLE 3. CONTINUED.

	intermediate to felsic tuffs					
Map No.	**37**	**40**	**55**	**56**	**59**	**62**
Sample No.	**7A-612-1**	**7A-617-1**	**7A-724-1**	**7A-738**	**7A-788**	**7A-877**
SiO_2	68.9	70.3	71.9	68.4	66.2	62.9
Al_2O_3	14.9	15.2	14.8	16.2	18.9	15.6
Fe_2O_3†	4.17	3.04	4.29	3.25	3.25	4.82
FeO	–	–	–	–	–	–
MgO	1.42	1.18	1.47	1.15	0.91	1.05
CaO	2.82	1.97	1.71	3.26	2.30	4.84
Na_2O	4.22	3.86	3.36	3.41	3.18	3.59
K_2O	1.06	1.86	0.60	1.30	2.84	1.57
H_2O^+‡	1.0	1.3	1.40	1.00	1.60	4.50
H_2O^-	–	–	–	–	–	–
CO_2	–	–	–	–	–	–
TiO_2	0.43	0.41	0.47	0.37	0.53	0.55
P_2O_5	0.11	0.09	0.12	0.11	0.14	0.18
S	–	–	–	–	–	–
MnO	0.05	0.03	0.05	0.04	0.05	0.06
total	99.1	99.2	100.2	98.5	99.9	99.7
specific gravity	2.67	2.68	2.71	2.67	2.69	2.72

	intermediate to felsic coarse fragmentals					
Map No.	**1**	**2**	**3**	**4**	**6**	**42**
Sample No.	**7A-010-1**	**7A-014-1**	**7A-022-1**	**7A-023-1**	**7A-040-1**	**7A-093-2**
SiO_2	67.6	72.5	61.2	69.6	68.5	74.2
Al_2O_3	16.7	14.0	17.9	15.8	15.9	17.1
Fe_2O_3†	4.59	1.31	0.60	0.62	4.49	2.96
FeO	–	3.85	4.30	2.37	–	–
MgO	1.56	4.13	4.02	1.09	1.81	0.33
CaO	3.26	0.23	5.05	2.21	3.29	0.14
Na_2O	1.33	0.20	1.60	5.27	3.90	0.04
K_2O	1.87	1.21	2.65	1.21	1.21	2.78
H_2O^+‡	1.9	1.22	0.89	0.80	1.1	1.70
H_2O^-	–	0.47	0.49	0.49	–	–
CO_2	–	0.25	0.22	0.21	–	–
TiO_2	0.55	0.53	0.76	0.40	0.52	0.53
P_2O_5	0.13	0.15	0.22	0.09	0.15	0.13
S	–	0.30	0.02	0.03	–	–
MnO	0.1	0.26	0.15	0.05	0.09	0.03
total	99.6	100.6	100.1	100.2	101.0	99.9
specific gravity	2.74	2.75	2.75	2.66	2.70	2.76
Ba		200	200	260		
Co		9	10	7		
Cr		45	60	25		
Cu		50	20	10		
Li		35	15	9		
Ni		30	35	15		
Pb		40	80	10		
Zn		115	120	50		

TABLE 3. CONTINUED.

	intermediate to felsic coarse fragmentals					
Map No.	9	11	52	15	16	17
Sample No.	7A-101-3	7A-113-1	7A-281	7A-516	7A-528	7A-530-1
SiO_2	67.3	67.8	66.1	66.8	65.3	66.1
Al_2O_3	16.0	15.2	15.4	15.5	15.8	15.1
Fe_2O_3†	1.15	4.67	5.50	0.65	1.09	1.24
FeO	2.82	–	–	3.93	3.48	3.41
MgO	1.90	1.96	3.23	2.88	2.28	3.26
CaO	3.40	3.92	5.26	4.04	6.08	3.10
Na_2O	4.36	4.09	0.24	0.40	1.74	2.81
K_2O	0.79	0.45	1.02	2.67	1.23	1.60
H_2O^+‡	0.62	1.0	2.50	0.93	0.82	0.78
H_2O^-	0.38	–	–	0.52	0.56	0.58
CO_2	0.30	–	–	0.58	0.90	0.13
TiO_2	0.46	0.50	0.47	0.57	0.65	0.66
P_2O_5	0.12	0.11	0.13	0.16	0.18	0.17
S	0.02	–	–	0.05	0.01	0.23
MnO	0.07	0.05	0.11	0.09	0.07	0.08
total	99.7	99.8	100.0	99.8	100.2	99.2
specific gravity	2.69	2.69	2.79	2.77	2.75	2.72
Ba	380			190	160	120
Co	15			15	15	7
Cr	40			50	60	60
Cu	200			25	50	20
Li	10			10	15	20
Ni	30			25	40	35
Pb	20			15	15	10
Zn	145			25	75	45

	intermediate to felsic coarse fragmentals					
Map No.	22	24	53	38	39	54
Sample No.	7A-549-1	7A-557-1	7A-599-1	7A-613-1	7A-614-2	7A-649-1
SiO_2	59.3	69.1	67.7	68.3	64.3	56.1
Al_2O_3	15.0	16.0	16.2	16.2	14.4	29.7
Fe_2O_3†	4.93	0.24	3.72	2.5	0.80	0.63
FeO	–	2.96	–	–	4.08	–
MgO	4.19	0.62	1.40	1.06	2.44	0.10
CaO	7.85	3.84	2.24	1.59	5.96	1.87
Na_2O	0.46	4.30	5.34	5.81	2.05	4.05
K_2O	3.09	0.84	0.97	1.43	1.00	2.46
H_2O^+‡	3.1	0.20	1.60	1.1	2.07	2.20
H_2O^-	–	0.41	–	–	0.30	–
CO_2	–	0.20	–	–	2.18	–
TiO_2	0.48	0.58	0.40	0.69	0.50	1.11
P_2O_5	0.13	0.15	0.11	0.15	0.13	0.14
S	–	<0.01	–	–	0.07	–
MnO	0.20	0.17	0.05	0.05	0.10	0.01
total	98.7	99.6	99.7	98.9	100.4	98.4
specific gravity	2.84	2.72	2.69	2.68	2.72	2.78
Ba		230			140	
Co		5			15	
Cr		45			40	
Cu		20			45	
Li		9			20	
Ni		15			15	
Pb		10			<10	
Zn		35			80	

TABLE 3. CONTINUED.

	intermediate to felsic coarse fragmentals			intermediate to felsic flows		
Map No.	57	63A	63B	43	44	45
Sample No.	7A-776	7A-1003M	7A-1003F	7A-158-3	7A-174-1	7A-187-1
SiO_2	67.0	52.0	69.0	67.6	66.1	63.8
Al_2O_3	16.3	14.9	17.5	16.6	18.2	17.3
Fe_2O_3†	4.04	19.3	2.56	3.94	3.76	5.89
FeO	–	–	–	–	–	–
MgO	1.44	2.92	0.18	0.73	0.78	1.89
CaO	3.38	5.90	0.78	2.57	2.46	3.14
Na_2O	3.87	1.81	7.93	4.99	4.96	4.22
K_2O	1.08	0.38	0.35	1.24	1.55	1.40
H_2O^+‡	1.70	1.00	0.60	1.10	1.40	1.00
H_2O^-	–	–	–	–	–	–
CO_2	–	–	–	–	–	–
TiO_2	0.46	0.42	0.57	0.60	0.65	0.59
P_2O_5	0.11	0.12	0.15	0.15	0.16	0.16
S	–	–	–	–	–	–
MnO	0.07	0.34	0.08	0.04	0.04	0.09
total	99.4	99.1	99.7	99.6	100.1	99.5
specific gravity	2.67	3.03	2.64	2.71	2.69	2.73

	intermediate to felsic flows				porphyritic "spherulitic" flows	
Map No.	46	47	49	50	5	23
Sample No.	7A-187-3	7A-200	7A-205-1	7A-231	7A-025-1	7A-551-2
SiO_2	65.6	63.2	70.9	65.1	73.4	72.9
Al_2O_3	17.0	16.6	17.4	17.2	14.7	19.5
Fe_2O_3†	5.50	7.47	2.36	5.21	0.0	0.95
FeO	–	–	–	–	1.78	–
MgO	1.49	1.65	0.57	1.04	0.82	0.00
CaO	2.79	5.23	2.02	3.53	1.48	0.15
Na_2O	4.60	2.75	3.86	3.67	0.79	3.80
K_2O	1.30	1.09	1.22	1.13	3.61	0.30
H_2O^+‡	0.70	0.80	1.20	1.50	0.79	0.5
H_2O^-	–	–	–	–	0.48	–
CO_2	–	–	–	–	0.16	–
TiO_2	0.60	0.57	0.54	0.68	0.37	0.80
P_2O_5	0.17	0.22	0.15	0.19	0.10	0.07
S	–	–	–	–	0.29	–
MnO	0.07	0.29	0.04	0.06	0.03	0.01
total	99.8	99.9	100.2	99.3	98.8	99.0
specific gravity	2.72	2.82	2.70	2.72	2.72	2.77
Ba					410	
Co					<5	
Cr					25	
Cu					620	
Li					15	
Ni					5	
Pb					130	
Zn					3300	

TABLE 3. CONTINUED.

	unsubdivided and porphyritic intermediate to felsic rocks					
Map No.	7	48	25	60	61	51
Sample No.	7A-090-1	7A-204-1	7A-574-2	7A-803	7A-820	7A-270-2
SiO_2	66.2	67.4	67.6	68.6	68.0	66.5
Al_2O_3	16.7	16.6	19.1	17.5	16.9	16.4
Fe_2O_3†	0.93	4.81	1.19	3.69	3.95	4.83
FeO	3.33	–	0.89	–	–	–
MgO	1.33	1.17	0.15	0.71	0.76	2.90
CaO	4.20	3.62	1.73	2.64	3.02	3.20
Na_2O	2.31	3.49	4.82	2.70	3.58	1.24
K_2O	1.46	0.71	2.18	1.56	0.98	2.50
H_2O^+‡	1.39	0.70	0.45	1.70	1.70	1.90
H_2O^-	0.50	–	0.45	–	–	–
CO_2	0.34	–	0.21	–	–	–
TiO_2	0.55	0.58	0.23	0.56	0.51	0.49
P_2O_5	0.14	0.18	0.05	0.16	0.14	0.13
S	0.16	–	<0.01	–	–	–
MnO	0.07	0.15	0.09	0.04	0.05	0.07
total	99.6	99.4	99.1	99.9	99.6	100.1
specific gravity	2.73	2.74	2.70	2.69	2.67	2.73
Ba	250		970			
Co	8		<5			
Cr	35		7			
Cu	10		<5			
Li	20		6			
Ni	20		<5			
Pb	15		20			
Zn	50		20			

	metasediments		Summit Lake stock			
Map No.	19	20	26	28	29	30
Sample No.	7A-542-2	7A-543	585-2	601-2	603-1	603-2
SiO_2	52.0	52.8	69.5	67.3	69.5	68.8
Al_2O_3	16.3	13.7	15.2	16.1	14.8	15.1
Fe_2O_3†	8.92	1.45	3.65	2.65	3.42	4.20
FeO	–	12.2	–	–	–	–
MgO	4.78	3.44	1.08	1.12	1.33	1.43
CaO	10.8	8.20	3.98	1.36	4.40	4.51
Na_2O	2.71	3.03	4.51	5.95	4.43	4.39
K_2O	0.51	0.60	0.59	2.44	0.27	0.39
H_2O^+‡	1.20	1.06	0.60	2.00	1.00	0.70
H_2O^-	–	0.56	–	–	–	–
CO_2	–	0.15	–	–	–	–
TiO_2	1.18	2.02	0.42	0.39	0.43	0.50
P_2O_5	0.11	0.16	0.11	0.17	0.10	0.15
S	–	0.07	–	–	–	–
MnO	0.19	0.49	0.05	0.03	0.05	0.04
total	98.7	99.9	99.7	99.5	99.7	100.2
specific gravity	2.92	3.01	2.71	2.62	2.71	2.72
Ba		120				
Co		40				
Cr		105				
Cu		10				
Li		45				
Ni		50				
Pb		<10				
Zn		130				

TABLE 3. CONTINUED.

	Summit Lake stock			
Map No.	31	32	33	34
Sample No.	604-1	605	606-1	607-1
SiO_2	69.3	55.7	69.1	68.2
Al_2O_3	15.2	21.3	15.5	15.1
Fe_2O_3†	3.24	5.28	3.02	4.43
FeO	–	–	–	–
MgO	1.40	1.95	1.31	1.33
CaO	4.47	7.18	4.51	4.41
Na_2O	4.75	5.87	4.73	4.01
K_2O	0.24	0.12	0.14	0.79
H_2O^+‡	0.50	1.10	0.80	0.80
H_2O^-	–	–	–	–
CO_2	–	–	–	–
TiO_2	0.44	0.62	0.44	0.51
P_2O_5	0.10	0.19	0.09	0.15
S	–	–	–	–
MnO	0.04	0.05	0.03	0.02
total	99.7	99.4	99.7	99.7
specific gravity	2.71	2.70	2.67	2.69

NOTES.

Map No. = number used on location map, Figure 4.
For partial analyses:
† total iron oxide is expressed as Fe_2O_3
‡ loss on ignition (L.O.I.) is expressed as $H2O^+$.
Trace element analyses: values are expressed in parts per million.

TUFFS

Epiclastic mafic to intermediate metavolcanics occur as interflow units ranging in thickness from a few centimetres to several hundred metres throughout the mafic to intermediate mafic flows in the Willet Lake area (Amukun 1977b), and in the thin unmappable mafic units within the felsic metavolcanic rocks.

The mafic to intermediate epiclastic rocks are comparable to flow rocks of similar metamorphic rank in outcrop, but they differ in that they are grey-green with a brownish tint. The bedding is usually evident and is composed of chloritic-hornblendic and feldspathic layers from a few centimetres to several tens of centimetres thick that display no internal structures.

In outcrop and under the microscope, ash and small volcanic fragments less than 4 mm in size predominate, and volcanic fragments of lapilli size are rare.

The grain size and mineralogy are variable as with the mafic flows, but less altered epiclastic mafic to intermediate tuffs consist mineralogically of anhedral to subhedral hornblende and sodic plagioclase with epidote, chlorite, carbonate, biotite, quartz, sphene and opaque minerals.

LAPILLI TUFF, TUFF BRECCIA AND PYROCLASTIC BRECCIA

Coarse fragmental mafic to intermediate rocks are minor components of the map area; these were mapped by the author during the 1977 field season, in outcrops about 2438 m east of Suicide Pond (local name) just south of the map area.

Field and laboratory studies suggest that these coarse fragmental rocks have a pyroclastic origin. The evidence includes: angular pumiceous and vesicular fragments, non-aluminous mafic matrix and pillow fragments.

These rocks are grey green and are composed of a greenish (chlorite) matrix which generally constitutes over 30 percent of the rock, and in which mafic, intermediate and felsic fragments of lapilli and bomb size, (which generally weather to lighter shades of grey and green) are interspersed. Thin section studies reveal that the clasts consist of hornblende, plagioclase and chlorite aggregates with accessory carbonate, epidote, muscovite, biotite, sphene and quartz-calcite-amphibole-filled amygdules. The hornblende and plagioclase grains are generally up to 8 mm in longitudinal length, both probably representing secondary growth. The matrix is generally chloritic and is composed of chlorite, quartz, carbonate, epidote, apatite, biotite and opaque minerals.

ROCKS OF UNKNOWN ORIGIN (1a, 1f, 1j and 1n)

Three rock types have been produced by the deformation and alteration of the mafic to intermediate metavolcanics: a) foliated chlorite schists (unit 1j), produced by deformation and cataclasis; b) massive, fine- to coarse-grained, hornblende-rich schists and amphibolites caused by recrystallization (unit 1f); and c) foliated to cataclastic and banded fine- to medium-grained schists and gneisses (unit 1a). In addition, mafic to intermediate feldspar ± quartz porphyries (unit 1n) are often found associated with, but crosscutting, all the mafic to intermediate metavolcanics. These rocks may be flows of intrusive or tuffaceous origin.

Intermediate To Felsic Metavolcanics

The intermediate to felsic metavolcanic rocks range in composition from siliceous andesite (58 to 60 percent SiO_2) through dacite to rhyolite, and the bulk composition of fragment and matrix as well as that of selected rock fragments indicates a calc-alkalic affinity (Figure 3b). These rocks constitute over 90 percent of the metavolcanics and 75 percent of all the rocks of the map area and are predominantly fragmental types.

The intermediate to felsic metavolcanics display features characteristic of deposits having an extremely variable depositional environment ranging from subaerial to submarine. The intermediate to felsic metavolcanics represent both proximal and distal facies. Proximal relatively shallow water eruptions are represented by pumiceous pyroclastic rocks and vesicular flows. Deep water or distal depositional facies are represented by thinly laminated tuffs.

Based on structural relationships, these rocks are the oldest rocks of the map area and underlie the mafic unit at Little Marshall Lake, and the metasediments throughout the map area. A greater proportion of the intermediate to felsic metavolcanics are pyroclastic, with only few reworked or epiclastic members. Where these rocks have been thoroughly reworked, they have been grouped with the metasediments.

A variety of clast sizes are present and include ash (up to 2 mm in diameter), lapilli (2 to 64 mm) and bombs (over 64 mm). These fragments vary in shape from lenticular and subrounded (in the larger sizes), to subangular (in the smaller sizes). The classification of pyroclastic rocks in the map area is based on the nomenclature of Fisher (1966, p.292). The rocks have also been subjected to alteration by tectonic deformation and metamorphism, and are described below under the headings which follow.

TUFFS

These rocks are similar in occurrence to their mafic to intermediate counterparts. The siliceous tuffs are characteristically well laminated and weather grey to pale white (cream). Bedding thickness ranges from a few centimetres to tens of metres such that on some outcrops bedding is evident, while on others no bedding may be seen, presumably because the bed may be thicker than the outcrop area itself.

Petrographic study of the tuffs reveals that these rocks are severely altered: feldspars are altered to sericite, muscovite, saussurite-zoisite, epidote and carbonate, while the ferromagnesian minerals are altered to secondary hornblende and/or actinolite-tremolite, carbonate, chlorite, biotite, sphene, magnetite and other opaque minerals. The rocks are composed of grains of quartz and feldspar 0.03 mm in diameter, set in a finer grained matrix consisting of quartz, feldspar and uncommon albite twins with the accessory alteration minerals described above. Bedding, where preserved, can be defined by variations in the proportion of mafic minerals. The feldspar and mica grains display an elongation which produces a well-developed foliation that obliquely intersects bedding.

The chemical compositions of the intermediate to felsic tuffs is summarized in Table 3.

LAPILLI TUFF, LAPILLISTONE, TUFF BRECCIA AND PYROCLASTIC BRECCIA

In general, the coarse fragmental rocks are light grey or cream coloured on weathered surface, and are composed of a grey-green to white matrix within which elliptical and/or angular light-colour-weathering rock fragments of intermediate to felsic composition are distributed (Photo 1). Fragment shape is probably a consequence of deformation in a majority of the outcrops. In the area south of Dog Island, on the south shore of Marshall Lake, outcrops in which the mafic matrix is green (chloritic) and garnetiferous are common. In all cases, the fragment sizes span the entire nomenclature scheme of Fisher (1966). The composition of the larger fragments is generally intermediate (andesite to dacite) to felsic (dacite to rhyolite). Consequently, clast outlines can usually be readily detected in areas where the matrix is mafic in composition (Photo 2), and on weathered surfaces elsewhere in the map area. Ultramafic fragments were not recognized anywhere in the map area, probably because these fragments would be more susceptible to alteration than the felsic types.

Microscopically, the matrix material ranges from mafic to felsic in composition. The mafic varieties are composed of fine-grained chlorite (up to 50 percent), carbonate, amphibole (hornblende and/or actinolite-tremolite) and minor amounts of sphene, almandine, epidote, muscovite and opaque minerals. The intermediate to felsic varieties are composed of sericite, quartz, sodic plagioclase, muscovite and carbonate, with or without almandine, actinolite-tremolite, zoisite, epidote, pyrite, sillimanite, saussurite and opaque minerals. The elliptical or lens-shaped fragments of lapilli, bomb and block sizes are

Photo 1. *Tuff breccia to pyroclastic breccia, showing elliptical clasts of mafic, intermediate and felsic composition, in a sericitic matrix. From outcrops on the south shore of Marshall Lake, at the old mineral exploration camp.*

made up of recrystallized metacrysts and grains of quartz (up to 20 percent), anhedral to subhedral feldspar, amphibole, sericite, zoisite, epidote, carbonate, muscovite, biotite and almandine.

The results of chemical analyses performed on samples of some of these coarse fragmental rocks are presented in Table 3.

Features Indicative of Specific Origins The classification of pyroclastic rocks (Fisher 1966) followed in this report is essentially nongenetic. Several specific features indicative of the origin of the rocks of the map area are common. These are described below in detail. Those fragmental rocks of unknown origin are designated as volcanic breccias.

Self (1976, p.645, 665) has pointed out that the recent pyroclastic deposits on Terceira, in the Azores, have three main constituents: vesicular juvenile material, nonvesicular juvenile material, and nonjuvenile lithic fragments and juvenile crystals.

At Marshall Lake these three main constituents can all be recognized.

Vesiculated Juvenile Material (Pumice) In the field, pumiceous material was readily recognizable in the fragmental rocks throughout the map area. The presence of pumice in abundance and features such as welding are indicative of ash flows (Smith and Ross 1966). In the present area, pumice fragments have not been subjected to welding and devitrification, have commonly remained relatively intact and occur in many localities within the pyroclastic rocks. An ash flow origin for these deposits, though likely, is not confirmed.

In the map area, tectonic deformation seems to have affected the original shape of the pumice fragments. These fragments occur as flattened and collapsed features which retain their vesicular texture (Photo 3). The examination of thin sections, cut in the plane of foliation, reveals that the pumiceous fragments appear as irregularly shaped lenticular features made up of greatly elongated tube-like pore spaces which give the specimen a fibrous structure. The pore spaces are partly filled by calcite, quartz with or without alkalic feldspar, epidote and chlorite; the pumice contains about 50 percent pore space in the weathered hand specimen. Viewed perpendicular to the plane of foliation, the collapsed and flattened pumice fragments appear as elongated coins similar to the "flat plate-like discs" referred to by Smith and Ross (1966). The fragments are predominantly quartzofeldspathic and are suspended in a very fine-grained matrix in which no shards or other features typical of welding were recognized. Overall, evidence for welding is lacking in the map area. According to Smith and Ross (1966, p.24):

> **"The most striking field characteristic that marks the transition from non-welded to welded material is the change in appearance of the pumice fragments. Welding and compaction together, without devitrification and vapour-phase crystallization (filling of pores), cause the pumice to change in shape and color. Fresh glassy pumice normally ranges from white or gray to some shade of brown.... However, during flattening and welding the pumice darkens until...it becomes black and obsidian-like (in the strongly welded zones)."**

Photo 2. *Air-fall breccia consisting of large felsic blocks (50%) in a mafic matrix. South shore of Marshall Lake, 400 m south of Dog Island.*

Dark-coloured fragmental rocks have not been observed in the map area and the degree of flattening in these rocks is not severe. It may be possible that welded zones are entirely lacking in the Little Marshall Lake area, a situation comparable to the recent pumice fall deposits in the Azores (Self 1976).

Features that are diagnostic of either subaerial or subaqueous depositional environments were not observed. Although pyroclastic flows and welded ash flow tuffs of subaerial origin are worldwide in occurrence in rocks of many ages, such deposits have rarely been recognized in sequences of marine rocks (Niem 1977, p.49).

During the field mapping, several features that suggest a shallow-water depositional environment include the following:

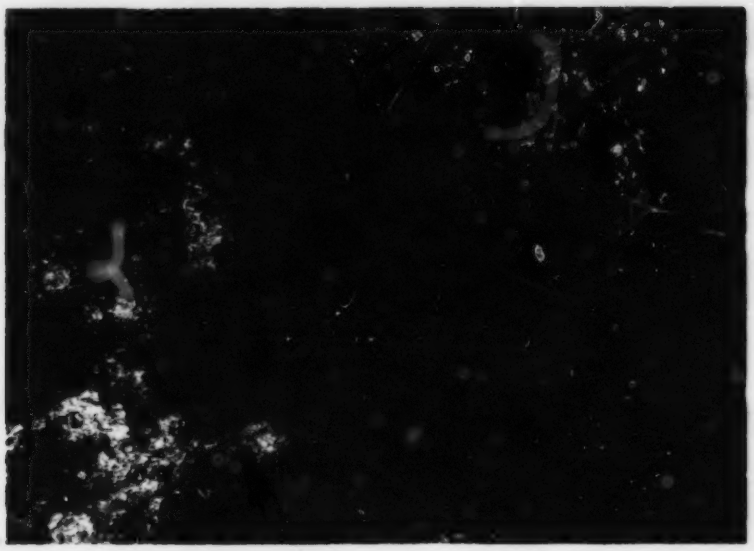

Photo 3. *Flattened and collapsed pumice fragments due to tectonic deformation. The pumice fragments have retained their vesicular texture. South shore of Marshall Lake, east of the mineral exploration camp.*

1. The pyroclastic deposits that are possibly ash flows are separated by, and interbedded with, intermediate to felsic pillowed flows and flow breccias and clastic quartzose and feldspathic metamorphosed sandstone and mudstone units which are well laminated, graded and cross-bedded.
2. In the Gazooma area of the Imperial Oil–Teck Corporation property, the rocks are highly vesicular. This could have been caused by extreme frothing, or by rising gas escaping from a voluminous magma of low viscosity, possibly under shallow water conditions (Aramaki 1961, p.522).

Nonvesicular Juvenile and Nonjuvenile Lithic Fragments Most of the dense rock fragments from the intermediate to felsic, and mafic to intermediate rocks of the Little Marshall Lake area display some evidence favouring a pyroclastic origin, for example:

1. The nonvesicular fragments are combined with pumiceous rock fragments in the outcrops of possible ash flow deposits; these were recognized in the field and in microscopic studies.
2. In the breccia with the mafic matrix on the south shore of Marshall Lake, south of Dog Island (unit 2z), elongate tubular amygdules containing amphibole, quartz, epidote and almandine occur on the rims or edges of several fragments (Photo 4). Although the feature may be partly modified by metamorphism, glowing ejecta of low viscosity have been known to vesiculate fully (into pumice in places) upon quick cooling; examples of this phenomenon have been described by Aramaki (1961, p.518 and 522). In the Little Marshall Lake area, the feature may be explained as a quench texture caused by red-hot clasts that either travel through the air (hence the field name air-fall breccia) or roll on the slopes of a steep volcano, and come to rest in a relatively cool (sedimentary or mafic flow) environment.
3. Evidence of sorted and broken fragments which can be fitted to form one large, possibly original fragment (Photo 5) may also indicate that the fragments were possibly of phreatic explosive origin.

Juvenile Crystals Several outcrops with bluish "quartz eyes", euhedral plagioclase phenocrysts and other primary crystals occur throughout the map area. The original crystals probably were derived from the fragmented magma.

FLOWS

Some of the intermediate to felsic lavas are pillowed, retaining ellipsoidal or ovoidal pillow structures generally greater than 30 cm across the shorter side. In most cases, deformation has obliterated the original form to render top determinations unreliable; however, in the outcrops on the small island in Marshall Lake near the source of the Gripp River, the original shape is better preserved and tops can be determined with some confidence.

Photo 4. *Tuff breccia in which elongate, tubular amygdules (dark spots) occur near the rim of several breccia fragments. From outcrops about 400 m south of Dog Island.*

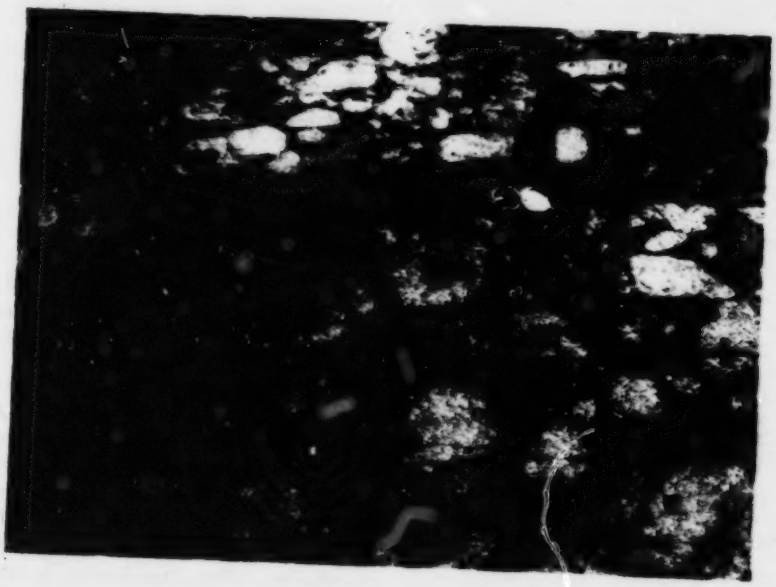

Photo 5. *Tuff breccia outcrop in which some broken breccia fragments can be fitted together to form larger, possibly original, fragments that may have shattered upon impact. From outcrops west of, but near locality of Photo 4.*

Like the mafic to intermediate pillowed flows, one of the characteristic features displayed by pillows of intermediate to felsic composition is that the cores of the pillows are considerably lighter in colour than the rest of the pillows and consist of visible epidotized plagioclase which upon thin section examination is seen to consist of epidote, quartz, muscovite, calcite, sericite-saussurite and zoisite. The selvages of the felsic to intermediate pillows are of two types. In one type exposed on the small islands at the source of the Gripp River and on the south bank of this river and the west end of Marshall Lake, the selvages are up to 5 mm wide and consist predominantly of mica (muscovite and biotite) amphibole, epidote, carbonate, plagioclase and quartz. In the second type, exposed on outcrops on the north shore of Marshall Lake, the selvages are thin (only 0.5 mm or less) and consist predominantly of epidote, chlorite and quartz.

Flows with porphyritic phases are best exposed on the small islands at the source of the Gripp River, where plagioclase phenocrysts average 2 mm in length but are up to 1 cm in length in places. In the less altered samples of the intermediate to felsic porphyritic flows, the plagioclase phenocrysts are partly saussuritized, sericitized and zoisitized, and are composed predominantly of sodic plagioclase, quartz and biotite. Accessory minerals include actinolite-tremolite, muscovite, epidote, carbonate, chlorite, and traces of clinozoisite, sericite, apatite, ilmenite, sphene and opaque minerals.

Other textural features found in the intermediate to felsic flows of the map area include amygdules and vesicles, and spherulites and/or variolites.

Distinct units of pillow breccia occur in the felsic to intermediate flows. In these outcrops, lithic vesicular and nonvesicular fragments (constituting 50 to 60 percent of the rock) occur with pillow fragments (about 10 percent) in a fine-grained sericitic and/or chloritic matrix (30 to 40 percent). The bulk composition of fragments and matrix is intermediate as determined by chemical analysis.

Although the intermediate to felsic flows are generally massive in outcrop, relic flow layering is recognizable in scattered outcrops within the map area as defined by a subtle variation in the grain size of quartz and plagioclase, and in the variable distribution of dark minerals. The thickness of these layers is variable, from a few millimetres to several centimetres.

The chemical and mineralogical compositions of samples of intermediate to felsic lava are given in Table 3.

PORPHYRITIC (SPHERULITIC) FLOW

This unit is distinct in outcrop and appears to have been formed in part by the metasomatism of felsic flows; this metasomatic effect is best observed near the felsic dikes which intrude these flows. In the map area, outcrops of this unit occur on the north and south shores of Marshall Lake. In outcrops on the north shore of Marshall Lake, due north of Marshall Creek, the unit is about 30 m wide, whereas on the south shore of the lake, the unit is about 10 m wide and is made up of subunits 50 to 100 cm wide. Both occurrences of this unit weather to light-grey with pinkish shades and the rocks determined by x-ray and petrographic methods to consist mainly of the alteration minerals sericite, actinolite-tremolite, kyanite, sillimanite and andalusite. The felsic dikes may probably best be described as spherulitic subvolcanic intrusions in which the spherules consist of the acicular and stellate minerals already named. Rocks of a similar texture and metamorphic mineralogy have been reported in the Timmins area by Hogg (1955), who reported "a spherulitic granophyre" in which "radiating spherulitic development" occurs in the porphyritic granophyric rock (Hogg 1955, p.24-25).

The unit is best exposed about 1280 m northeast of the large mineral exploration camp on the south shore (west end) of Marshall Lake, but petrographically similar rocks are found within flows and fragmental rocks of intermediate to felsic composition. In outcrop and in hand specimen, the rocks are remarkably similar texturally and mineralogically to the other flows in that they are composed of large white metacrysts of feldspar and quartz set in a groundmass that consists in part of 2 to 3 mm spherulitic structures made up of clear feldspar and/or quartz and a radial, stellate pattern that consists of metamorphic minerals identified petrographically as kyanite, actinolite-tremolite blades and intergrowths, and overgrowths of muscovite, sillimanite and andalusite. In thin section, two textures (not superimposed) are discernible within these rocks. The first type is a true porphyry in which unaltered and twinned phenocrysts of calcic plagioclase, up to 12.7 mm long, and quartz are suspended in a groundmass in which intergrowths of quartz and plagioclase, and also patches of kyanite, muscovite, sillimanite (fibrolite), actinolite-tremolite, andalusite(?) and opaque minerals, are present. The second type is a spherulitic texture consisting of large quartzo-feldspathic aggregates up to 15 mm long containing predominantly quartz, minor amounts of feldspar, and traces of muscovite, epidote, carbonate and opaque minerals, suspended in a matrix with elongated blades of kyanite up to 1 cm long, slender fibres of sillimanite, muscovite, quartz, feldspar, actinolite-tremolite, andalusite(?), epidote and opaque minerals. The mineralogical assemblage is discussed further under the section "Metamorphism of the Metavolcanics".

The chemical and mineralogical compositions of the rocks are given in Table 3. These flows are rhyolitic in composition, and their silica content is among the highest of the values analyzed in the map area (approximately 73%).

DIKES OF QUARTZ AND/OR FELDSPAR PORPHYRY AND FELSITE

Numerous dikes of quartz and/or feldspar porphyry, felsite and altered equivalents (as described under the section "Schists and Gneisses" below), which average 10 m wide, crosscut the felsic pyroclastic rocks and flows, as well as the mafic metavolcanic rocks. The porphyritic texture is common (except for the felsites), but the origin of the quartz metacrysts is usually open to a number of possible interpretations. These porphyritic dike complexes probably constitute the feeder zones through which the volcanic pile was extruded, as indicated by the presence of the following features: 1) porphyritic and granophyric textures; 2) spherulitic and/or miarolitic cavities; 3) sharp variations in mafic mineral content; and 4) chilled margins to the dikes, and gradational contacts with their extrusive equivalents.

In thin section, both the porphyries and some felsites contain phenocrysts of quartz and/or sodic plagioclase 1 to 10 mm long, and 3 mm in diameter on average; these are distributed in a fine-grained groundmass in the porphyries, or a cryptocrystalline matrix in the felsites, but in both cases grains of chlorite, carbonate, muscovite, sodic plagioclase, epidote, sphene and opaque minerals are present.

The results of chemical and mineralogical analyses are listed in Table 3.

SCHISTS AND GNEISSES

Several rock types produced by the alteration of the intermediate to felsic metavolcanics have been mapped separately. These are: 1) foliated sericite schists, 2) foliated chlorite and/or amphibole schists, 3) mica schists and gneisses, and 4) foliated and banded, fine- to medium-grained quartz-feldspar-amphibole schists and gneisses. These rocks have been classified by the predominant component metamorphic minerals — sericite, chlorite, hornblende, actinolite-tremolite, muscovite-biotite, feldspar and quartz — regardless of origin. The chemistry and origin of these rocks is highly varied.

Although the original mineralogy, textures and structures of the volcanic rocks are partly destroyed, several features are still preserved and enable recognition of the fragmental nature of the volcanic pile.

METAMORPHISM

The products of regional (?) metamorphism in the map area are characterized by various assemblages of the minerals: albite, plagioclase, actinolite, hornblende, biotite, prochlorite, epidote, quartz and calcite, with or without muscovite, iron-rich garnet, pyrite, pyrrhotite and magnetite.

A distinctive suite of metamorphic minerals, including staurolite, kyanite, sillimanite and andalusite, is found in volcanic rocks in close proximity to mineralized areas. Such minerals are not characteristic of the regional metamorphism of volcanic rocks under normal conditions and may be the result of metasomatic alteration as discussed later in this report under "Economic Geology".

METASEDIMENTS

In the map area, the metasediments are formed of clastic and chemical units. Metasedimentary units along the north and south margins of the map area overlie the metavolcanic rocks; the clastic metasedimentary rocks are essentially derived from the erosion and redeposition of volcanic material. Quantities of banded oxide-facies (interbedded magnetite ironstone and chert) and sulphide-facies (interbedded pyrite-pyrrhotite ironstone and graphite-bearing chert) iron formation occur as distinct units, especially within the clastic metasediments, and less commonly within the metavolcanic and gabbroic rocks. The iron formation units can be interpreted from aeromagnetic survey maps to be continuous around the perimeters of the major fold limbs, within the clastic and ferruginous metasedimentary units.

The metasedimentary rocks are foliated and have been metamorphosed to a rank equivalent to that of the metavolcanic rocks. However, the metamorphic mineralogy of the metasedimentary rocks differs from that of the metavolcanics because of differing initial compositions. The metamorphic assemblage of the clastic metasediments includes: quartz, staurolite, almandine, cordierite, muscovite and plagioclase, with or without biotite, carbonate, epidote, chlorite, microcline and minor amounts of iron and titanium oxides. The metamorphic rank of this mineral assemblage is the almandine subfacies of the lower almandine-amphibolite facies (Turner 1968).

Clastic Metasediments

Based on the current prevalent size of the epiclastic fragments in the rocks, the predominant rocks of the clastic metasediments are sandstones (0.06 to 2 mm diameter clasts) and mudstones (less than 0.06 mm diameter), according to the grain size scale of Wentworth (1927). The altered equivalents of these rocks (phyllite, argillite, slate, staurolite and graphite schist and quartz-feldspar paragneiss) are localized in areas of intense metamorphism south of Lake "B" (*see* Legend footnote "g", Map 2531, back pocket) which is the eastern extension of the Albert Lake unit reported by Amukun (1977b, p.23).

SANDSTONES

In view of the increase in grain size due to metamorphic recrystallization, the sandstones do not fit the conventional classification utilizing the Wentworth particle size scale. Because of this, the metasediments were not subdivided into arenites, wackes and mudstones since this classification depends on percent of matrix.

In the Little Marshall Lake area, the majority of the coarsest grains range in size from 0.03 to 2 mm

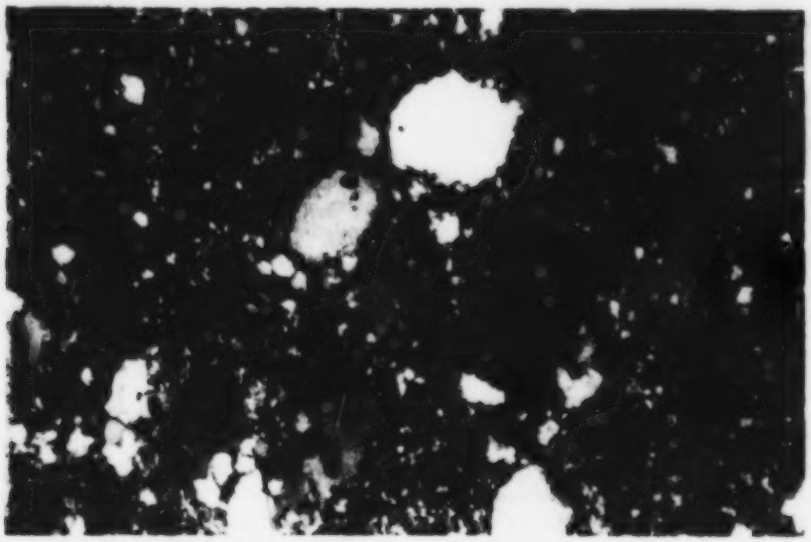

Photo 6. *Photomicrograph of sandstone showing relict sedimentary texture with subrounded grains of quartz and feldspar in a recrystallized matrix of calcite, chlorite, epidote, staurolite, cordierite, almandine and muscovite.*

(sandstones) and the remainder of the particle sizes fall in the range less than 0.03 mm in diameter (mudstones). Conglomerate was not recorded in the map area.

The sandstones are best exposed just south of Lake "B", where coarse-grained sandstones are interbedded with fine-grained mudstones and with chemical metasediments.

The sandstones are medium- to coarse-grained and weather to shades of grey and brown. Individual layers may vary greatly in thickness, ranging from 10 to 20 cm to a maximum of 50 m. In thin section, the rocks consist of a framework of subangular to subrounded grains of quartz (20 to 30 percent), plagioclase (up to 60 percent) orthoclase (10 to 15 percent) and lithic clasts (1 to 5 percent) in a recrystallized matrix of calcite, chlorite, epidote, staurolite, cordierite, almandine and muscovite (Photo 6).

MUDSTONES

The mudstones are not restricted to any part of the map area, however, these rocks are usually interbedded with the coarser grained sandstones. The mudstone bed thickness never exceeds 10 cm.

Finer grained mudstones are distinguished from the tuffs with difficulty. The slates, siltstones and argillite beds are thinly laminated, fine-grained, argillaceous rocks characterized by bedding-plane foliation and can be distinguished from each other by the degree of induration. These rocks are pale brown or grey on weathered surfaces, and display varying colours ranging from dark brown or grey to black on fresh surfaces.

In thin section, the mudstones are revealed to be very fine grained (less than 0.03 mm in diameter), and are made up of quartz and plagioclase (60 to 80 percent) set in a matrix of hornblende and biotite (25 percent), epidote (2 percent) and accessory chlorite, apatite, muscovite, tourmaline and opaque minerals. No rock fragments were recognized, probably because these may have been stretched out by deformation. The bedding is reflected by the distribution and grain size of anhedral to subangular grains of quartz and feldspar, and by the relative concentration of the mafic minerals.

SCHISTS AND GNEISSES (3b, 3c, 3d and 3k)

Several outcrops of thinly bedded, hornblende-feldspar-mica and/or quartz schist or gneiss, and laminated schists dominated by hornblende (amphibolites) and chlorite (chlorite schists), occur in the map area, particularly in the area north of Marshall Lake (Photo 7). These units may represent highly metamorphosed and deformed arenaceous and argillaceous rocks. On the north shore of Marshall Lake, a few outcrops of quartz-feldspar-amphibole-mica rocks retain sedimentary textures and pebbles, and have been designated as pebbly sandstones.

These rocks contain biotite, almandine, muscovite, hornblende, quartz and epidote and are hence partly similar compositionally to the metasedimentary rocks of the map area.

Photo 7. *Thinly bedded hornblende-feldspar-quartz gneiss consisting of quartz-feldspar-mica units (light) and narrow, fine-grained chlorite-hornblende units (dark) within the metasedimentary unit north of Marshall Lake. From outcrops located about 1.5 km east of Lake "A".*

Chemical Metasediments

IRON FORMATION

By definition, these rocks are chemical precipitates containing more than 15 percent total iron (Gross 1965, p.23).

These rocks contain the iron minerals magnetite, pyrite and pyrrhotite, with jasper(?) quartz, carbonate, rutile and sphene. Bedding thickness is variable from 10 cm to 100 m. Thin section examination reveals that the rocks consist of microlayers of crystalline and cryptocrystalline grains of quartz within which octahedra and subangular crystals of magnetite and euhedral phenocrysts of pyrite and pyrrhotite are dispersed.

The 35 million ton iron deposit of Stewart Lake Iron Mines of Ontario Ltd. (Property No. 20) is nowhere exposed on surface; the limits of the deposit were interpreted by aeromagnetic surveys and diamond drilling by exploration companies.

CHERT, FERRUGINOUS CHERT

These rocks total up to 15 percent iron, and include those iron-bearing rocks that are excluded by the definition of Gross (1965).

Recrystallized chert in the map area occurs: 1) just south of Lake "B", 2) about 1524 m south of the central lake of Lakes "I", and 3) in all of the localities listed below for ferruginous chert. Several outcrops of ferruginous chert occur: 1) on the small islands between Dog and Deeds islands in Marshall Lake, 2) on the peninsula 305 m south of the camp on Deeds Island, and 3) on the outcrops located 1200 m west of Little Marshall Lake.

METAMORPHOSED INTERMEDIATE TO MAFIC INTRUSIVE ROCKS

These rocks are metamorphosed gabbroic (units 4b, 4c, 4f) or dioritic (unit 4g) rocks that may or may not contain quartz and potassic feldspar. Although not as common, lamprophyres (unit 4j) are also described in this section.

In view of the severe metamorphism and deformation to which these rocks have been subjected, it is difficult if not impossible to distinguish them from the mafic to intermediate extrusive metavolcanics in those areas where volcanic features are absent. The distinction is difficult because original grain sizes may be modified and plagioclase is severely altered.

In the map area, the mafic to intermediate intrusive rocks are distributed as follows: 1) as two small semicircular gabbroic stocks (each about 2.6 km² in area), which intrude the metavolcanics and metasediments, located on the north shore of Marshall Lake (Marshall Lake intrusion) and on the north shore of Little Marshall Lake (Little Marshall Lake intrusion); 2) as numerous discontinuous bodies of gabbroic and dioritic rocks of unknown origin; and 3) as dikes and sills of gabbro, diorite and lamprophyre.

Marshall Lake and Little Marshall Lake Intrusions

The rocks of the intrusions are medium to coarse grained, except at the borders with the country rocks where chilling has produced fine-grained varieties. Besides chilled contacts, other intrusive features include: the presence of country rock xenoliths (Marshall Lake intrusion), the occurrence of several

TABLE 4. MODAL ANALYSES OF LAMPROPHYRES, GABBROS AND DIORITES.

	Lampro-phyre	Lampro-phyre	Diorite	Horn-blende Gabbro	Gabbro	Horn-blende Gabbro	Horn-blende Gabbro
Sample	7A-012-2	7A-015-2	7A-069-1	7A-133-1	7A-137-2	7A-552-2	7A-568
Quartz	-	-	8	15	30	5	3
Plagioclase (An)	6 (An50)	- -	30 (An29)	- -	- -	20 (An45)	- -
Chlorite	-	-	5	-	-	-	-
Biotite	-	-	2	-	-	-	-
Hornblende	-	-	50	70	60	68	94
Sericite	1	5	-	2	-	2	-
Clino-pyroxene	3	-	-	-	-	-	-
Epidote	-	-	-	10	10	-	2
Carbonate	-	-	5	-	-	-	-
Sphene	-	-	-	2	-	-	-
Opaques	-	10	-	1	-	5	1
Matrix	90	-	-	-	-	-	-

dikes emanating from the main intrusion (both intrusions), and possible igneous layering in the Marshall Lake intrusion.

In the Marshall Lake intrusion, a coarse-grained hornblende gabbro is the predominant rock type. This rock is dark grey to black on the fresh surface and weathers to brownish tints because it contains trace to moderate amounts of magnetite, pyrrhotite and pyrite. The concentration of the iron minerals is in one case strong enough to outline an anomalous, northeast-trending magnetic zone 2.4 km long and 50 m wide.

At the Little Marshall intrusion, diorite and quartz-bearing diorite seem to be the common rock types. The rocks are dark green to grey on fresh surfaces, weather to light grey and range in texture from massive, equigranular, medium to fine grained to foliated and porphyritic. The intrusion is the northern extension of the intrusion previously described by Amukun (1977b, p.35).

Gabbroic-Dioritic Dikes, Sills and Pods

The dikes, sills and pods of gabbro, diorite and/or quartz-bearing varieties occur throughout the map area. The grain size of these bodies is controlled by their widths, which range from 30 cm to several tens of metres. The rocks of the apophyses are similar texturally and mineralogically to those of the intrusions where the apophyses have not been affected by narrow thicknesses.

In the intrusions and the apophyses, metagabbro and metadiorite seem to grade into and are associated with one another. In thin section studies, all of the less altered varieties of these rocks have retained an ophitic to subophitic texture, and pseudomorphs of the primary pyroxene mineralogy. The rocks are composed largely of subhedral and zoned andesine plagioclase phenocrysts, pseudomorphs of pyroxene which are now almost all completely altered to actinolite-tremolite, uralite and hornblende. Other minor minerals include epidote, chlorite, iron oxide, sphene and quartz. The modal abundances of a selection of gabbroic/dioritic rocks from the map area are given in Table 4.

LAMPROPHYRE

The lamprophyre is distinguished in the field by 1) more severe weathering than the gabbro-diorite, into deeper shades of brown, 2) the occurrence as discontinuous dikes, pods, dikelets and small sills less than 10 m long and 25 cm wide, 3) more severe alteration than the gabbros/diorites — often some sections consist of over 50 percent calcite, chlorite and epidote, and 4) the occurrence of the mafic minerals (biotite, hornblende, actinolite-tremolite) both as phenocrysts and in the groundmass, and the occurrence of the felsic minerals only in the groundmass.

Microscopically, the lamprophyres are composed of a high percentage (over 80 percent) of mafic minerals which form the phenocrysts as well as the fine-grained crystalline groundmass (panidiomorphic texture). Modal abundances of selected lamprophyre samples are given in Table 4.

INTERMEDIATE TO FELSIC INTRUSIVE ROCKS

Summit Lake Stock

The Summit Lake stock is a discrete, composite, metamorphosed granitic stock, the eastern limit of

TABLE 5. MODAL ANALYSES OF THE SUMMIT LAKE STOCK.

	Quartz Diorite	Quartz Diorite	Quartz Diorite	Quartz Diorite	Quartz Diorite	Trondh-jemite	Quartz Diorite/ Trond.	Quartz Diorite
Sample	7A-581-1	7A-582-1	7A-583-1	7A-584-1	7A-585-1	7A-585-2	7A-586-1	7A-587
Quartz	55	30	36	20	74	35	20	30
Plagioclase (An)	15 –	53 –	40 (An50)	52 (An32)	<7 –	45 (An48)	32 (An12)	51 (An48)
Chlorite	–	3	5	7	–	trace	–	2
Biotite	–	<2	–	–	3	5	–	<10
Hornblende	15	7	10	15	<10	10	<2	<5
Epidote	1	<2	5	–	–	<1	5	trace
Opaques	2	2	<1	1	1	–	<1	1
Sphene	–	–	–	–	–	–	<1	–
Sericite	10	<1	3	5	–	<3	30	1
Actinolite-tremolite	–	–	–	–	<5	<1	–	–
Muscovite	–	–	–	–	–	–	–	–
Carbonate	–	–	–	–	–	–	–	–

	Quartz Diorite	Quartz-Feldspar Porphyry	Quartz Monzonite	Quartz Diorite	Quartz Diorite	Quartz Diorite	Quartz Diorite	Quartz Diorite
Sample	7A-589-1	7A-601-2	7A-603-1	7A-603-2	7A-604-1	7A-605	7A-606-1	7A-607-1
Quartz	35	<20	15	58	20	40	25	51
Plagioclase (An)	51 (An10)	65 (An7)	60 –	30 (An48)	63 (An38)	37 (An43)	58 (An40)	30 –
Chlorite	–	5	10	–	<2	<1	<1	–
Biotite	5	–	1	–	<2	–	–	10
Hornblende	7	–	<3	10	<7	15	10	7
Epidote	<1	–	<5	1	2	3	<2	–
Opaques	<1	<2	<1	1	<1	<2	<1	2
Sphene	trace	–	–	–	–	–	–	–
Sericite	trace	–	–	–	3	<2	3	–
Actinolite-tremolite	–	–	–	–	–	–	–	–
Muscovite	–	7	5	–	–	–	–	–
Carbonate	–	1	–	–	–	–	–	–

which intrudes the metavolcanic rocks on the western edge of the map area at Summit Lake. The stock underlies ten percent of the map area, and is cut by smaller hypabyssal intrusive dikes of quartz-feldspar porphyry, pegmatite, aplite, felsite, as well as by granitic dikes and quartz veins which are too small to map.

In the field, all samples of the Summit Lake stock were stained using a variation of the methods used by Chayes (1952) and Sclar and Fahey (1972) whereby the rocks were first immersed in dilute hydrochloric acid (to eliminate excess carbonates) before being treated with hydrofluoric acid (etch) and sodium cobaltinitrite (stain). The samples were then classified using the alkali feldspar to total feldspar ratio, together with the amount of quartz. Subsequent petrographic work, including the determination of plagioclase compositions and modal analyses (Table 5) were used to substantiate the field description.

In outcrop, the Summit Lake stock consists of pale grey weathering, medium- to coarse-grained, altered quartz diorite, trondhjemite and granodiorite. Several outcrops displaying later, quartz monzonite and quartz-feldspar porphyry dikes, as well as pegmatite with aplite, felsite, granitic dikes and quartz veins occur within the area of the Summit Lake stock. Outcrops of the stock also contain xenoliths

TABLE 6. MODAL ANALYSES OF DIABASE DIKES.

Sample No.	7A-008-2	7A-031-2	7A-080-2	7A-107-2	7A-109-2	7A-614-1	7A-615
Plagioclase (An)	50 (An60)	52 (An52)	48 (An60)	44 (An54)	50 (An52)	35 (An63)	50 (An55)
Clinopyroxene (Pigeonite)	40	35	40	35	35	-	30
Orthopyroxene (Augite)	-	-	-	-	-	24	-
Hornblende	3	5	5	5	5	15	<5
Biotite	-	-	1-2	-	trace	<1	-
Chlorite	-	trace	-	<1	2-3	-	-
Sericite	<2	<1	-	15	5	15	10
Epidote	-	-	-	-	-	-	<1
Opaques	5	7	5	1	5	10	3

of the fragmental metavolcanic rocks which it intrudes.

The fabric of the Summit Lake stock is variable; the margins of the stock are gneissose, while the core is massive to poorly foliated. The rocks are pinkish grey to white, and equigranular to porphyritic. Thin section examination reveals that the rocks are severely altered, to the extent that original granitic textures have been destroyed; the ferromagnesian minerals are all of secondary origin. The rocks may be porphyritic and contain subhedral to anhedral phenocrysts of plagioclase, quartz and hornblende set in a fine-grained groundmass of chlorite, sericite, epidote, opaque minerals, biotite and tremolite (Table 5).

Granitic Sheets and Dikes

Several outcrops of the Summit Lake stock are cut by and associated with smaller granitic intrusions consisting of dikes, sills, veins and sheets of quartz monzonite, quartz-feldspar porphyry, aplite, pegmatite, felsite, granitic material and quartz.

The mineralogical composition of these hypabyssal intrusive rocks (except for the quartz veins) is identical to that of the stock, with the exception that the hypabyssal intrusive rocks in certain cases contain some or abundant potassium feldspar (Table 5).

Texturally, the dikes, sills and veins are variable, depending on the thickness or width of individual dikes. That is, the wider bodies tend to be coarser grained and the narrower ones generally finer grained. The results of chemical analyses are given in Table 3.

PROTEROZOIC

MAFIC INTRUSIVE ROCKS

Numerous Middle to Late Precambrian (Proterozoic) diabase dikes postdate the granitic intrusions and hence crosscut all other rocks in the area. Some of these dikes form conspicuous ridges, and some of the major dikes are megaporphyritic.

The diabase dikes are part of a predominantly north-trending swarm offset by later faulting and range in thickness from 10 to 40 m.

The grain size of these rocks is controlled by dike widths. Although all the dikes have chilled margins, the fine- to medium-grained dikes are narrower (less than 15 m), whereas those dikes with widths greater than 15 m are medium to coarse grained.

Thin section study reveals that the rocks display typical diabasic texture between a "log jam" of labradoritic plagioclase laths and pyroxene phenocrysts. The groundmass consists of hornblende, biotite, chlorite, sericite, epidote, opaque minerals and quartz. A subophitic texture, in which the plagioclase laths are partially contained by larger pyroxenes, is also observed in some cases. The results of modal analyses are given in Table 6.

CENOZOIC

QUATERNARY

Pleistocene and Recent

Unconsolidated Pleistocene and Recent sediments cover about 85 percent of the surface of the map area.

The Precambrian topography has been modified by several glacial advances (Zoltai 1967). Ice movement in the map area was generally to the southwest (azimuthal bearings 230° to 250°) as determined from the measurement of glacial striations on outcrops. However, several glacial striations in the vicinity of Gripp Lake indicate a movement towards the south-southwest (azimuthal bearings 185° to 200°). Only two glacial striations are shown on the accompanying map.

Sand, clay and silt plains are the most widespread glacial deposits in the area, presumably outwash material from the Pleistocene ice sheets. Sev-

eral areas of boulder clay or till deposited by glaciers (moraine deposits) occur in several parts of the map area. Glaciofluvial deposits include rudely stratified accumulations of gravel and sand in esker ridges, and are common in the northern part of the map area.

Three types of Recent deposit are present in the map area. Two of these are associated with wetlands: 1) low, spongy terrain, generally water saturated, with trees and aquatic vegetation, including swamps (such as cedar, spruce and open swamps) and muskeg; 2) peat deposits composed of dark organic material produced by the partial decomposition and disintegration of mosses, trees and other plants that grow in wet places. The third type is of fluvial origin, and consists of local fluvial plains that have been produced in the larger rivers of the area by these rivers actively eroding their banks and depositing the material in other rivers or lakes.

Structural Geology

REGIONAL SETTING

The map area lies within but close to the north side of the east-northeast-trending Wabigoon Subprovince of the Superior Province. Rocks assignable to the English River Subprovince outcrop immediately to the north of the map area, on the shores of nearby Ara, Stone and Little Stone lakes.

The supracrustal rocks in general dip and face away from the granitic masses, suggesting perhaps that the granitic rocks may in part represent a base upon which the supracrustal rocks were deposited.

LOCAL STRUCTURE

Archean rocks of the map area have been severely deformed and metamorphosed during regional tectonic events that predate the Proterozoic.

The major fold and fault structures of the map area (Figure 5) are dominated by the Marshall Lake anticline, the Marshall Creek syncline, and the Banana Lake and Gripp Lake faults.

FOLIATION, LINEATION

The term foliation is used here to refer to parallel fabrics in metamorphic rocks resulting from tectonic deformation or from flowage during crystallization (synonymous with schistosity and flow cleavage, respectively). All of the supracrustal rocks of the map area and most of the rocks that intrude them display a well-developed metamorphic foliation that is defined by the subparallel orientation of micaceous minerals and by the flattening of pyroclastic fragments, pillows and boudins. Only the highly metamorphosed rocks resulting from tectonic and cataclastic deformation are schistose. One symbol is used on the map for foliation, schistosity and flow cleavage within the map area. The banding symbol is used to show compositional layering in distal fine-grained pyroclastic rocks. The banding is nearly always cut obliquely by foliation, but is parallel to the bedding in the metasediments. The term gneissosity is used here to define alternating schistose and granulose bands and lenses which differ in mineral composition and texture. Certain rocks of the Summit Lake stock have the appearance or character of a gneiss, though the fabric is insufficiently developed to be measurable, because of concentrations of dark zones rich in the mafic minerals biotite, hornblende and actinolite, which alternate with granulose quartzofeldspathic parts of the rock.

The term lineation is used here to encompass any linear structure resulting from primary flowage in igneous rock or secondary flowage in metamorphic rock, as shown by the rotation of mineral grains or other bodies, intersection of planes, slippage along gliding planes and growth of crystals. However, the most common lineations within the map area were noted: 1) in the bedding or foliation planes produced by the preferred orientation of mafic mineral aggregates, 2) at the intersection between bedding and foliation planes in the metasediments and tuffs, and 3) in the fragmental rocks as produced by stretched fragments (rodding).

JOINTS

Jointing is ubiquitous in the rocks of the map area. No attempt was made to map these features in detail. Previous studies of joints in the adjoining country (Amukun 1977b, 1977c) revealed that the joints in this part of the Wabigoon Subprovince tend to occur as two or three joint systems that 1) parallel the predominant fault and foliation directions, 2) parallel the major diabase dike strike, 3) intersect the trends of the major faults obliquely.

FAULTS

Several features indicative of faulting were observed in the map area:

1. lithologic or structural offsets
2. wall rock alteration and silicification
3. schistose, crushed and mylonitized wall rocks
4. strongly developed, closely spaced joint set patterns
5. physiographically high ridges (scarps) separated by deep valleys or gullies along which the country rock is sheared
6. positive and negative airphoto lineaments
7. straight, nonmeandering river sections along which country rocks are sheared and/or silicified
8. development of fault breccia

The fault along Lake "B" (Banana Lake—local name) is indicated by airphoto lineaments to extend west-northwest for 13 km from Lake "B" to Gripp Lake, where the lineament appears to be offset by the Gripp Lake fault and probably continues beyond this lake to the west (Figure 5). Fault breccia is present in places along this fault zone, but because of the lack of marker units on either side of the fault, it is not possible to determine the manner and direction of movement of this fault.

The Gripp Lake fault is defined by some of the fault features described above. It probably truncates the northwest extension of the highly vesicular and mineralized rock units at Gazooma and Teck Hill (local names, *see* Legend footnote "h", Map 2531, back pocket).

Other faults that have been recognized or inferred trend west, north-northwest, north and north-northeast, and are characterized by schistose rocks

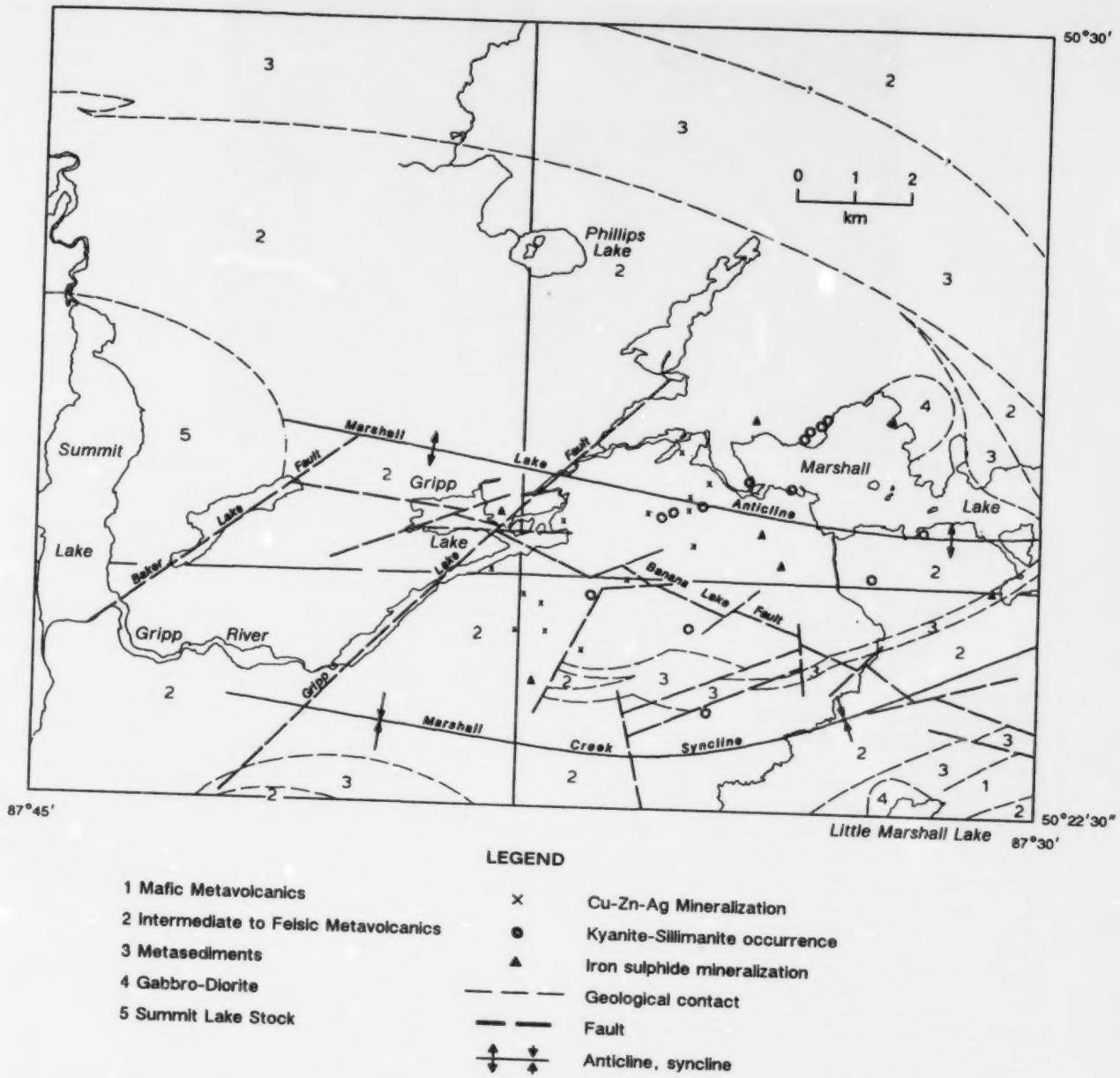

Figure 5. *General structure of the map area, showing the distribution of sulphide mineralization and kyanite-sillimanite occurrences.*

(sericite and/or chlorite schists), structural offsets and topographic lineaments. Some of the fault zones have been filled by diabase dikes, some of which are themselves offset by later dikes and fault zones that have in some cases similarly been filled by diabase dikes.

On the north shore of Marshall Lake, about 400 m northeast of Dog Island, pyroclastic fragments have been stretched in two directions, producing a checkerboard-like pattern (Photo 8). This peculiar feature is imprinted on the rocks by the intersecting strong foliations probably induced by two faults.

FOLDS

The metavolcanics and metasediments and the sulphide deposits which they contain have been folded and metamorphosed. A regional anticlinal structure (Marshall Lake anticline) and an associated tight synclinal structure (Marshall Creek syncline; *see*

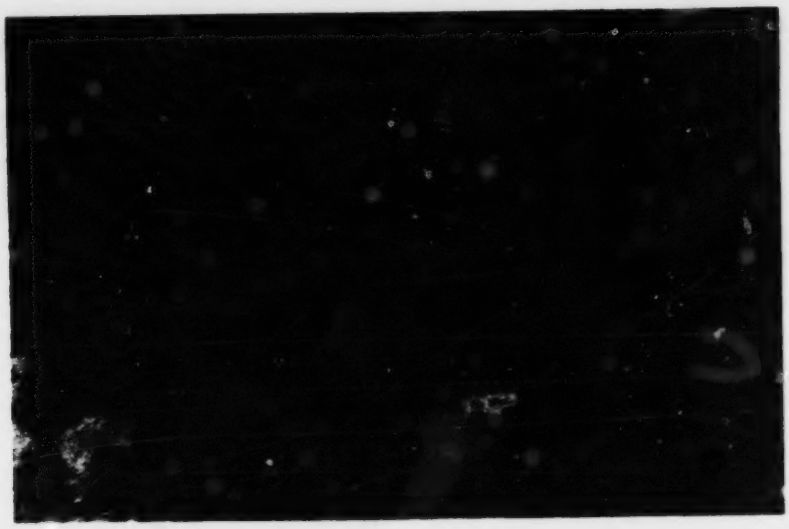

Photo 8. *Checkerboard feature probably produced by two strong fault-induced foliations, in pyroclastic rocks on the north shore of Marshall Lake, near Dog Island.*

Figure 5) have been interpreted from: 1) a few reliable top directions determined by pillow facings, cleavage-bedding relationships and by several reliable cross-beds and graded beds in the metasediments, and 2) by the outcrop distribution of the epiclastic rocks. The trace of the west-striking axial planes of the anticline and syncline are located just south of Marshall Lake, and in the southern part of the map area, respectively. The position of the Marshall Creek syncline is inferred from south facings north of Marshall Creek and pervasive north facings in the supracrustal rocks to the south of the map area (Amukun 1977b). The axis of the anticline is inferred to plunge to the east at 35 to 45 degrees to parallel most of the minor fold axes, but the attitude of the synclinal axis cannot be accurately defined for lack of sufficient structural and stratigraphic data.

Several minor fold features were recognized at many locations in the centre of the map area, in the form of minor (5 to 10 m in wavelength) antiform-synform fold pairs, drag folds and S and Z folds, especially within the well-bedded chert/ferruginous chert outcrops. In the folds formed in the chert/ferruginous chert outcrops, spectacular contorted beds caused by repeated similar folds are exhibited (cf., Photo 4 *in* Amukun 1977b).

CLEAVAGE

In outcrops on one of the small islands on the Gripp River where the strike of the shallow dipping lapilli tuff and tuff units has been rotated towards the northwest, a pronounced penetrative cleavage has developed at right angles to the rotated bedding. This feature is best developed in the competent bedded tuffs where it is accompanied by intense recrystallization.

Correlation between Geology and Aeromagnetic Data

The map area has been covered in whole and in part by a number of aeromagnetic surveys; these surveys have been undertaken by private mining companies in the interest of exploration, and by the provincial and federal governments in co-operation as part of the regional survey of Ontario (ODM–GSC 1963a, 1963b, 1965). The comparison of the aeromagnetic data of the area with the geology of the map area (Map 2531) shows a good correlation between the presence of iron formation and magnetic intensity. Because all of the iron formation units are stratiform and within or near the metasedimentary (chert/ferruginous chert) beds that are folded into the Marshall Lake anticline, a direct correlation can be made between this structure and the aeromagnetic data.

Two prominent features of the aeromagnetic maps are: 1) the outline of the Stewart Lake Iron Mines deposit in the northwestern part of the map area, and 2) the outline of the highly magnetic zone of magnetite-pyrrhotite-pyrite mineralization on the north shore of Marshall Lake, in the middle of the eastern part of the map area. The Stewart Lake Iron Mines deposit attains a maximum magnetic intensity of 64 500 gammas over a background of 60 500 gammas, while that at Marshall Lake reaches a maximum of 61 900 gammas above a 60 700 gamma background. The Stewart Lake Iron Mines deposit is not exposed, but was intersected at depth in the exploration drilling of Panther International Mining Company Ltd. and Stewart Lake Iron Mines of Ontario Ltd. between 1958 and 1962 (*see* section on "Description of Properties"). The Marshall Lake magnetite-pyrite-pyrrhotite deposit is exposed on outcrops on the north shore of Marshall Lake and was intersected at depth in the 1968 to 1969 exploration drilling of N.W.T. Copper Mines Ltd.

A weak magnetic anomaly of 61 160 gammas over a background of 61 000 gammas is defined in the area 1100 m west of Little Marshall Lake, where chert/ferruginous chert outcrops containing iron formation were mapped.

In the winter of 1978, the Ontario Geological Survey contracted out coverage of the map area for a high resolution magnetic survey. Even though this survey did not locate known areas of significant copper-lead-zinc mineralization, it successfully outlined a stratiform magnetic anomaly which would appear to be confined to a unit of finer grained pyroclastic rocks located on the Marshall Lake anticline. This confirms that strata are folded towards the northwest along the Gripp River between Gripp and Marshall lakes. Also, it suggests that the unit at the "main showing" near Lake "H" (*see* discussion of work by Teck Corporation in the section on "Economic Geology"), and at the recently exposed copper-bearing trench south of the Gripp River, is possibly traceable from Gripp and Marshall lakes northwest through Phillips Lake along the north limb of the fold.

Economic Geology

MINERAL DEPOSITS

There are no producing mines in the map area, but extensive geophysical surveys and diamond drilling (including over 6400 m on the Billiton showing alone) have been conducted in this camp since 1954. In addition, over 400 trenches have been excavated in the map area; in most of these trenches, some degree of iron and/or copper-zinc-silver sulphide mineralization, with or without lead sulphides and gold, is evident.

To date, no massive, strata-bound, lenticular bodies of iron-sulphide mineralization with associated base metals have been found in the layered volcanic rocks of the map area; however, the copper-zinc-silver sulphide mineralization is impressive in its extent and grade. Furthermore, a total of 1 307 980 t of base metal mineralization has been reported for the entire Billiton showing, currently on option to Imperial Oil Limited by Giant Gripp Mines Inc. Although the known mineralization appears to have been remobilized or concentrated by later folding, the map area displays some geological features characteristic of stratiform, massive, volcanogenic base metal sulphide deposits of the type associated with felsic volcanic rocks. These features are summarized below; comparably favourable associations are discussed later in the subsection under "Favourable Geological Features".

GENERAL GEOLOGIC SETTING

The Little Marshall Lake map area exhibits a sequence of Archean calc-alkalic metavolcanic rocks and volcanically derived metasedimentary rocks over 9000 m thick. This pile consists predominantly of (>75 percent) felsic volcanic breccias, which span the entire nomenclature scheme of Fisher (1966), accompanied by commonly banded or bedded volcaniclastic and chemical metasediments (15 percent). Numerous gabbroic/dioritic sills or dikes, making up only 3 percent of the map area, were intruded into the volcanic pile. A postdeformational, granitic pluton, which has a composition ranging from diorite to trondhjemite, was emplaced in the core of the Marshall Lake anticline at its western extremity; this intrusion constitutes approximately 7 percent of the map area. The presence of discontinuous stratiform and graded argillite beds frequently associated with ferruginous chert layers that may have been continuous, together with pillowed flows, imply a submarine depositional environment. Rare pyroclastic episodes probably produced bedded tuffs and local lenses of coarse breccias near proposed eruptive centres "A", "B", and "C" (*see* Map 2531, back pocket). Ash flows have not been recognized as such, but the area around Gazooma and the main showing are distinguished by abundant pumice and vesicular rocks.

A number of west-, northwest- and north-trending faults are the most obvious structural features in the map area. A major fault, which strikes north-northwest, traverses the map area between Lake "B" and Gripp Lake, and truncates and displaces the volcanic pile and the base metal mineralization. A number of north-northeast-trending lineaments are located in the southern half of the map area; some of these are probably expressions of Pleistocene deposits, but others are most likely the outlines of faults and shear zones.

Several Proterozoic diabase dikes intruded the older rocks, and one in particular (*see* Map 2531, back pocket) is indisputably a postmineralization feature, as it truncates and displaces the main zone of the Billiton showing.

Large-scale S and Z drag folds, probably related in time to the formation of the large proposed regional anticline, plunge towards the east at 35 to 45°. These folds seem to control 95 percent of the known mineralization in that all the better showings are located in the noses of minor folds. The most promising mineralized zone to date seems to lie concordantly in the middle of the major regional anticline of the map area, the Marshall Lake anticline.

METASOMATIC ALTERATION

The map area contains a number of base metal showings which have been and are currently being investigated by a number of companies. An understanding of the alteration processes to which these rocks have been subjected may be a valuable tool for future exploration. It has been noted by numerous investigators (Franklin *et al.* 1975) that it is difficult to distinguish and document the effects of metasomatic alteration in areas which have been subjected to subsequent regional metamorphism. Hydrothermal alteration zones have been documented around many massive sulphide deposits by numerous investigators (Franklin *et al.* 1975). These alteration zones are part of complex hydrothermal systems in which substantial redistribution of the bulk chemical components of the rocks affected has occurred. In these systems, mineral assemblages including chlorite, sericite and carbonate have been formed which are stable during subsequent greenschist facies regional metamorphism. Under such regional metamorphism the more obvious mineralized characteristics of the alteration zone have been obscured. Thus, it is only by careful detailed investigation of individual stratigraphic units that the anomalous chemical and mineralogical characteristics of alteration zones can be documented and used for exploration purposes.

If the rocks are subjected to higher grade regional or thermal metamorphism, the presence of an alteration zone may in some instances become more apparent through formation of a distinct metamorphic mineral assemblage reflecting the anomalous chemical composition of the most highly altered rocks: in the Noranda area, subsequent thermal metamorphism of the chloritic alteration pipes to several of the orebodies has produced the distinctive "dalmatianite" cordierite-anthophylite assemblage. The cordierite associated with the Manitouwadge deposits may also be formed in this manner. At Mattabi, the presence of kyanite close to the alteration zone has been recognized (Franklin *et al.* 1975) and while its presence may be due to its metastability, it is indicative of an ostensibly aluminous assemblage, probably formed by relative alkali leaching.

In the map area a distinctive suite of the metamorphic minerals staurolite, kyanite, sillimanite and andalusite is found in close proximity to the main concentrations of mineralization. It is probable that aluminosilicate concentrations represent zones of hydrothermal alteration which have resulted in alkali leaching and deposition of the sulphide mineralization.

The aluminous assemblage probably formed by local alteration (hydrothermal?) of the volcanic suite and not merely by the metamorphism of pelitic sediments. The "anomalous" metamorphic mineral assemblages, then, can be used as an exploration tool in the search for massive sulphide deposits which may also have formed as a result of the hydrothermal activity.

RELATIONSHIP OF MINERALIZATION TO GEOLOGIC FEATURES

The mineralization has been tested and sampled in varying degrees of detail by numerous companies, but more than ten selected showings were grab-sampled by the field party (not in appreciable detail) to substantiate the typical base metal mineralogy. In Table 7, all the assay results are presented; the location of all of the analyzed specimens is given in Figure 4.

Assays of mineralized specimens spatially associated with felsic calc-alkalic fragmental metavolcanic rocks confirm the nature of the sulphide mineralization that was observed to consist of: 1) ubiquitous disseminations in thin metamorphic garnetiferous amphibolite (actinolite-hornblende) lenses throughout the felsic metavolcanic rocks of the major showings, such as the "Teck", "Billiton" and others (Table 7), 2) disseminated to massive, lenticular shoots that probably represent migrated metal concentrations in the nose areas of minor folds, e.g. "G-1", "G-2", "New Copper", "New Zinc", "Main" (Billiton) and "Diabase" showings (Table 7), and 3) disseminated mineralization in local shear and silicified zones in the entire map area. In the main showings of the "Teck" and "Billiton" deposits, as well as elsewhere in the map area, pronounced sericite-muscovite schists are closely related to higher grades of mineralization and might indicate local alteration zones. Gahnite and fuchsite also occur in the mineralized zones of the "New Zinc" showing.

The sulphide mineralization consists of pyrite, chalcopyrite, silver minerals, sphalerite, galena and gold (in order of abundance). Values of cadmium and bismuth (probably as the sulphides greenockite and bismuthinite) have been reported by Bayne (1970, p.6). A unique feature of this camp is that pyrite is the only iron sulphide of noteworthy abundance in the areas of base metal mineralization, and that the iron minerals pyrrhotite and magnetite are of minor abundance, if not absent.

In polished sections, the sulphides consist of large, irregular, anhedral grains of intergrown chalcopyrite, sphalerite and pyrite, as well as gangue minerals (Photo 9). In the larger "blebs" of sphalerite, exsolution textures are represented by inclusions of anhedral, small grains of chalcopyrite in the larger euhedral to subhedral grains of sphalerite.

Base metal mineralization appears to pinch and swell along strike and as established by structural and geophysical methods, is confined to finer grained pyroclastic rocks (tuffs and lapilli tuffs) within a unit that wraps around the Marshall Lake anticline near its axial zone. The unit can be traced from the area of Gripp and Marshall lakes, northwest through the area south of Lake "A" and Phillips Lake and beyond.

FAVOURABLE GEOLOGICAL FEATURES

The Gripp Lake–Marshall Lake area can be compared with established base metal massive sulphide mining camps elsewhere in the Canadian Shield. Similarities in the geological setting provide a basis for comparison between these camps and the Little Marshall Lake area, and may provide clues that could be useful in exploration. A most striking example is the nearby Geco and associated ore bodies at Manitouwadge. Here, the regional geological structure is a broad east-plunging synform which hosts an orebody that follows a dragfold system within the syncline. In this example the lenticular, continuous zone of mineralization has been interrupted and offset by several diabase dikes and the major fault system of the area (Milne 1969; Brown and Bray 1960).

Host Rock Association

The mineralization occurs in dacites and rhyodacites of calc-alkalic affinity, particularly in the fragmental types. The mineralization seems to occur in one continuous stratigraphic unit. Although this unit is not directly associated with exhalites, a discontinuous ferruginous cherty unit seems to envelope the upper contact (and hence the periphery) of this metavol-

TABLE 7. SUMMARY OF ASSAY RESULTS.

No.	Showing (Local Name)	Claim No.	Cu (%)	Zn (%)	Pb (%)	Ni (ppm)	Ag (oz./ton)	Au (oz./ton)	Total Fe (%)
1	main ("103") zone	KK23033 (TB346442)	2.05	4.0	0.2300	-	3.15	trace	
	Duchene (5)-IF "G-1"-"G-2"	TB459326(?) TB395052							34.9
2	Duchene (5)-IF "G-1"-"G-2"	TB395052	21.6	2.3	0.0239	ND	14.69	0.05	
3	Duchene (5)-IF "G-1"-"G-2"	TB395052	15.8	1.3	0.0030	ND	7.49	0.05	
4	Duchene (5)-IF "G-1"-"G-2"	TB395052	7.7	0.2290	0.0010	ND	trace	trace	
5									
6	Swamp ("96") zone	KK24346	0.0114	0.0054	0.0032	ND	trace	trace	
7	Swamp ("96") zone	KK22808	0.0480	0.0660	0.0132	ND	trace	trace	
8	Swamp ("96") zone	KK22808	0.88	0.82	0.0128	-	1.0	trace	
9	New Zinc ("83" or "x" zone)	KK24347	0.91	1.70	0.0130	-	1.31	trace	
10	New Zinc ("83" or "x" zone)	KK24347	0.68	3.75	0.0121	-	1.34	trace	
11	New Zinc ("83" or "x" zone)	KK24347	0.1700	6.5	0.88	12		0.02	
12	North Zone	KK23033 (TB346422)	0.4800	6.6	0.0092	ND	0.78	trace	
13	Kendon Camp	TB346424	0.1120	0.4050	0.3500	-	0.84	trace	
14			0.0270	3.22	0.2700	-	0.18	trace	
15	diabase zone	KK23033 (TB346422)	0.0090	0.80	0.3740	-	0.36	trace	
16	diabase zone	KK23033 (TB346422)	1.67	12.4	0.2400	ND	4.1	trace	
17	diabase zone	KK23033 (TB346422)	0.1120	3.72	1.2	ND	1.72	trace	
18	"no name"	TB321389	0.4650	0.0460	0.0215	ND	trace	0.02	
19	"no name"	TB459024	0.0148	0.0148	0.0098	ND	trace	trace	
20	Lake "B" IF	TB455611							20.2
21		KK24329	0.1860	0.0240	0.0018		trace	trace	
22	Gripp River	TB321380	0.0780	0.0610	0.0020		trace	trace	
23	cabin area	KK24328	0.50	0.91	0.0015		trace	trace	
24		KK24328	1.12	0.0240	0.0100		0.01		
25	Gripp River north	TB455798	0.1070	-	-	-	-		
26		TB477098							3.10
27	iron formation in Little Marshall Lake	OPEN							42.6 43.5
28	ferruginous chert Lake "A"	OPEN							10.3 8.79
29	ferruginous chert Lake "A"	TB459325							31.7
30	ferruginous chert Lake "A"	TB476910							35.5
31	New Copper-trench 1		0.2550	0.0240	0.0027		trace	trace	
32	New Copper-trench 1	TB321380	6.0	0.0920	0.0010		1.52	trace	
33	New Copper-trench 1		4.6	0.1600	0.0015		1.49	0.05	
34	New Copper-trench 1		1.3	0.1000	0.0010		0.31	0.01	
35	New Copper-trench 2		0.2280	0.0142	0.0012		trace	trace	
36	New Copper-trench 2		1.8	0.0300	0.0014		0.10		
37	New Copper-trench 2	TB321380	0.1780	0.00280	0.0037		0.16	trace	
38	New Copper-trench 2		0.8600	0.0230	0.0010		0.24	trace	
39	New Copper-trench 2		9.4	0.0550	0.0014		3.73	0.01	
40	main ("103") zone Capitalized	KK23033 (TB346422)	2.3	13.0	0.3900		6.07	0.03	
41	main ("103") zone Capitalized								24.2
42	main ("103") zone Capitalized	TB476912							18.5
43	main ("103") zone Capitalized								17.6

TABLE 7. Continued.

No.	Showing (Local Name)	Claim No.	Cu (%)	Zn (%)	Pb (%)	Ni (ppm)	Ag (oz./ton)	Au (oz./ton)	Total Fe (%)
44	main ("103") zone Capitalized	TB476916							18.2
45	IF	OPEN							24.8
46	IF	OPEN							12.9
47	Deeds Point IF	TB459017							25.1
48	Old Zinc trenches	KK22798	0.3270	9.9	0.0052	ND	1.10	0.02	
49			0.3080	8.8	0.0094	ND	2.27	0.03	
50		TB407469	0.0060	0.0053	10	ND	trace	trace	
51	Koosel Prospect	TB455615							8.7
52		TB455620	0.0400	0.0086	0.0010	ND	trace	trace	
53		TB407476	0.0116	0.0134	0.0010	75	trace	trace	
54		TB407476	0.0039	0.0007	0.0010	75	trace	trace	
55		OPEN	0.0108	0.125	0.0010	75	trace	trace	
56		OPEN							4.65
57		TB321715	3.9	0.0137	0.0010	75	0.10	0.03	
58		TB441407	1.8	0.0080	0.0010	75	0.16	0.02	
59	"lease" showing		16.2	0.0260	0.0012	75	0.19	0.01	
60			6.8	0.2420	0.0010	75	2.34	0.04	
61			2.5	0.0590	0.0037	75	1.08	trace	
62			5.2	2.7	0.0047	75	4.49	0.07	
63			12.4	1.2	0.0047	75	8.80	trace	
64			4.1	0.2000	0.0010	75	1.89	0.01	
65	Cherry Hill		3.4	0.0450	0.0056	75	1.18	0.02	
66	Gazooma		4.1	0.1760	0.0013	75	1.87	0.01	
67			0.3760	0.0400	0.0035	ND	0.21	trace	
68	Cherry Hill		1.4	0.0870	0.0010	ND	0.53	0.02	
69			5.8	0.2710	0.0014	ND	2.39	0.01	
70			0.4400	0.0990	0.0080	ND	0.29	0.01	
71	Teck Hill		5.0	0.0380	0.0380	ND	1.33	0.04	
72			0.1510	2.1	0.2220	ND	0.42	0.02	
73	Teck Hill		2.8	0.0340	0.0050	ND	0.96	0.04	
74	Teck Hill		0.0670	0.0118	0.0072	ND	0.41	0.01	3.10
75	Teck Hill		2.9	0.0630	0.0010	ND	0.85	0.03	6.20
76	Teck Hill		0.1600	7.6	0.0053	ND	0.45	0.01	
77	Pelky Hwy.		0.1470	0.0198	0.0010	ND	0.07	trace	
78			5.8	0.4000	0.0013	ND	3.10	0.04	
79			0.0077	0.0072	0.0010	ND	trace	trace	
80			4.1	0.1840	0.0089	ND	2.96	0.08	23.6
81			6.2	0.4200	0.0760	ND	4.47	0.11	

ND: not detected
Assays by Geoscience Laboratories, Ontario Geological Survey.
For locations of all specimens see Figure 4.

canic unit. This type of host rock and the submarine environment of deposition is common to certain types of base metal deposits (Sangster and Scott 1976; Ridler 1973; and Solomon 1976).

Related Plutonic Rock Association

The volcanic pile in the Little Marshall Lake area is truncated in its western extremity by a diorite to quartz diorite granitic pluton, a feature not uncommon in Archean massive sulphide volcanogenic deposits (Sangster and Scott 1976; Solomon 1976). Such plutons are commonly considered to constitute part of the plumbing system, such that they are the heat source and the confining blocks to the mineralizing system.

Associated Tectonic Features

The most obvious structural features of the map area are numerous fault and shear zones that are marked by brecciation. The spatial relationship between faults and massive sulphide ores has been established in the Noranda area (Sangster 1972; Spence 1975; Solomon 1976). Although the mineralization in the Gripp Lake–Marshall Lake area has not to date been related directly to the most obvious structural features, subsequent comprehensive and detailed investigations may disprove or establish a possible genetic relationship.

Other Relationships

Kyanite is reported to occur in an alteration zone below the Mattabi orebody in the Sturgeon Lake area (Franklin *et al.* 1975). Several kyanite-

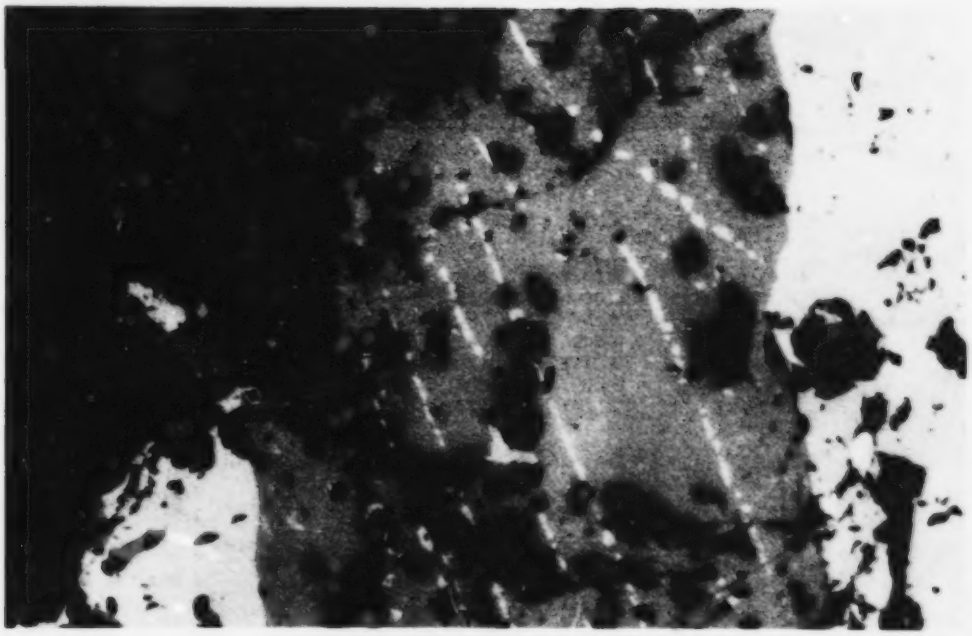

Photo 9. *A photomicrograph of a polished section showing typical exsolution and intergrowth texture of chalcopyrite and sphalerite. Pyrite shows similar textural relationships elsewhere in the sample. Gangue minerals are dark in the photograph.*

tremolite-muscovite ± anthophyllite zones occur in the area northeast of the camp at Marshall Lake. These zones may be related to the alteration zones containing the mineralization of the map area. Although their stratigraphic position in the Marshall Lake pile appears to be above the zone of mineralization, their age relationship remains unknown.

In a trench located on claim KK24347, near the southern border of KK24346 and south of Lake "H" (locally known as the "New Zinc" showing), a greenish-grey mineral, identified by x-ray methods as the zinc-rich spinel member gahnite ($ZnAl_2O_4$), is distributed irregularly in the mineralized zones containing sphalerite (0.82 to 6.5 percent zinc), chalcopyrite (0.17 to 0.91 percent copper), galena (0.01 to 0.88 percent lead), silver (1.0 to 1.34 ounces per ton), with traces of gold and nickel (specimens 8 to 11, Table 7). This mineral has been found both at the Geco and Willroy orebodies as well as in ores of other highly metamorphosed terrains (Suffel *et al.* 1971), where it has been interpreted as a metamorphic product of sphalerite, thus placing those deposits as premetamorphic.

The chrome mica, fuchsite, also occurring at the "New Zinc" showing and confined by x-ray methods, is reported to be associated with the mineralized areas of the Timmins camp. This may be indicative of subsequent thermal metamorphism of the alteration zones of mineralized areas.

ECONOMIC POTENTIAL

The concept that coarse-grained felsic pyroclastic rocks located near the eruptive centres of volcanic activity are prime hosts of base metal deposits is widely accepted and has been documented from Precambrian base metal mining camps both in Canada (Sangster and Scott 1976) and throughout the world. Other workers have emphasized areas adjacent to coarse-grained pyroclastic rocks that consist of overlying, subaqueous, thin-bedded, siliceous, volcanic metasediments as prime hosts of strata-bound volcanogenic massive sulphide deposits, (Sangster and Scott 1976; Spence and De Rosen–Spence 1975; Anderson and Nash 1972; Hutchinson 1973; Larsen and Webber 1977). It should be noted that the coarse pyroclastic rocks of the Marshall Lake area had previously been interpreted as quartzose metasediments of the Marshall Lake Group (Langford 1959). Because of this interpretation, no detailed study of these pyroclastic rocks had apparently been applied to base metal exploration.

To date, no massive, strata-bound, lenticular bodies of pyrite mineralization with associated base metals have been found in the layered volcanic rocks of the map area; however, the copper-zinc-sil-

ver (± lead and gold) sulphide mineralization in the Marshall Lakes area as exposed by trenching is impressive in its extent and grade.

Spence (1975), Spence and De Rosen–Spence (1975), Larsen and Webber (1977) and Solomon (1976) have emphasized the close spatial association of massive sulphide ores with the contacts between felsic (rhyolitic) metavolcanic rocks and mafic (basaltic) effusive rocks. In the areas 1) between Lake "B" and Little Marshall Lake, and 2) north of Willet Lake, just south of the current map area (*see also* Amukun 1977b, p.81), mafic pillowed flows (and associated tuffs) are in contact with intermediate to felsic pyroclastic rocks, and therefore might represent a Noranda-type massive sulphide depositional environment.

The recognition of metamorphic minerals indicative of alteration "pipes" or possible channelways for the flow of mineralized brines has been utilized elsewhere for outlining alteration zones and unrecognized or unexposed ("blind") mineralized areas. To date, this approach has not been utilized in the map area apparently because of the poor rock exposure outside the central part of the map area, and because of inadequate detailed studies. If it could be documented that the aluminous assemblage formed by alteration of the volcanic suite is more widespread than so far recognized, then the anomalous kyanite-andalusite assemblages could be used as an exploration tool in the search for massive sulphide deposits which may also have formed as a result of the hydrothermal activity.

The situation in the map area is excellent with regard to economic facilities. Adequate water and timber are present for mining purposes. The map area is well situated in regard to transportation and mining facilities: it is located 25 to 30 km north of the transcontinental line of the CNR, and 80 km north of an Ontario Hydro Electric Power Commmission line, as well as a 30-inch line of the Trans Canada National Gas Pipeline Company. The proximity of the gas pipeline could be beneficial for direct reduction processes required for the beneficiation of ore. The 21 km drilling supply road which starts from Toronto Lake, off the extension of the Auden Road, can be improved for overland transportation.

DESCRIPTIONS OF DEPOSITS AND PROPERTIES

At the beginning of the field season, the central part of the map area was staked and registered to a number of individuals and companies. After the completion of field mapping, additional ground was staked in the area southeast of Lake "A". The claims originally registered to a few individuals were transferred to the Giant Gripp Mines Inc.–Imperial Oil Limited parcel of land. All of the map area around and north of Lake "A" and Phillips Lake was open for staking except for property with a known iron deposit leased to Stewart Lake Iron Mines of Ontario Ltd.

TABLE 8. LIST OF PROPERTIES.

1. Callinan Flin Flon Mines Ltd. (1955)
2. Consolidated Marbenor Mines Ltd. (1955)
3. Cox, Nolan
4. Doucett, George
5. Duchene, Roger J.
6. Fayle, Richard
7. Feeley, Vincent (1965)
8. Galley, David R. (Silver–Miller Mines Ltd.) (1955)
9. Giant Gripp Mines Inc.–Imperial Oil Limited
10. Hibbart, Nick
11. Johnson, Don R.
12. Kasner, R.J.
13. Lill, John R. (Prospectors Airways Co. Ltd.) (1955)
14. Lynx Canada Ltd. (Callinan Flin Flon Mines Ltd.) (1955).
15. MacLean, D.
16. McCharles, Harold
17. New Goldvue Mines Ltd. (1955)
18. N.W.T. Copper Mines Ltd. (1969)
19. Saari, T.
20. Stewart Lake Iron Mines of Ontario Ltd.
21. Teck Corporation Ltd.
22. Ternowesky, John (Yellowknife Bear Mines Ltd.) (1955); Sheridan Miller Mines Ltd. (1955)
23. Thornsteinson, David
24. Weirmer, M.

The status of the deposits and properties described below is as of December 31, 1977. Exploration work done on deposits and properties is described alphabetically under the heading of the names of the company or individual who last performed the exploration work. The date in brackets after the name is the date of the last major work done. The number in brackets following each property, prospect or occurrence description heading refer to property location numbers on Map 2531 (back pocket).

The properties are listed in Table 8 and illustrated on Figure 6.

CALLINAN FLIN–FLON MINES LTD. (1955) (1)

In 1955, Callinan Flin–Flon Mines Ltd. owned 12 mining claims numbered KK8819 to KK8820 inclusive, KK8825 and KK8836 to KK8844 inclusive, that straddled the current map area and the Willet Lake map area to the south (Amukun 1977b). The property then included the central part of Lynx–Canada Ltd. ground (14).

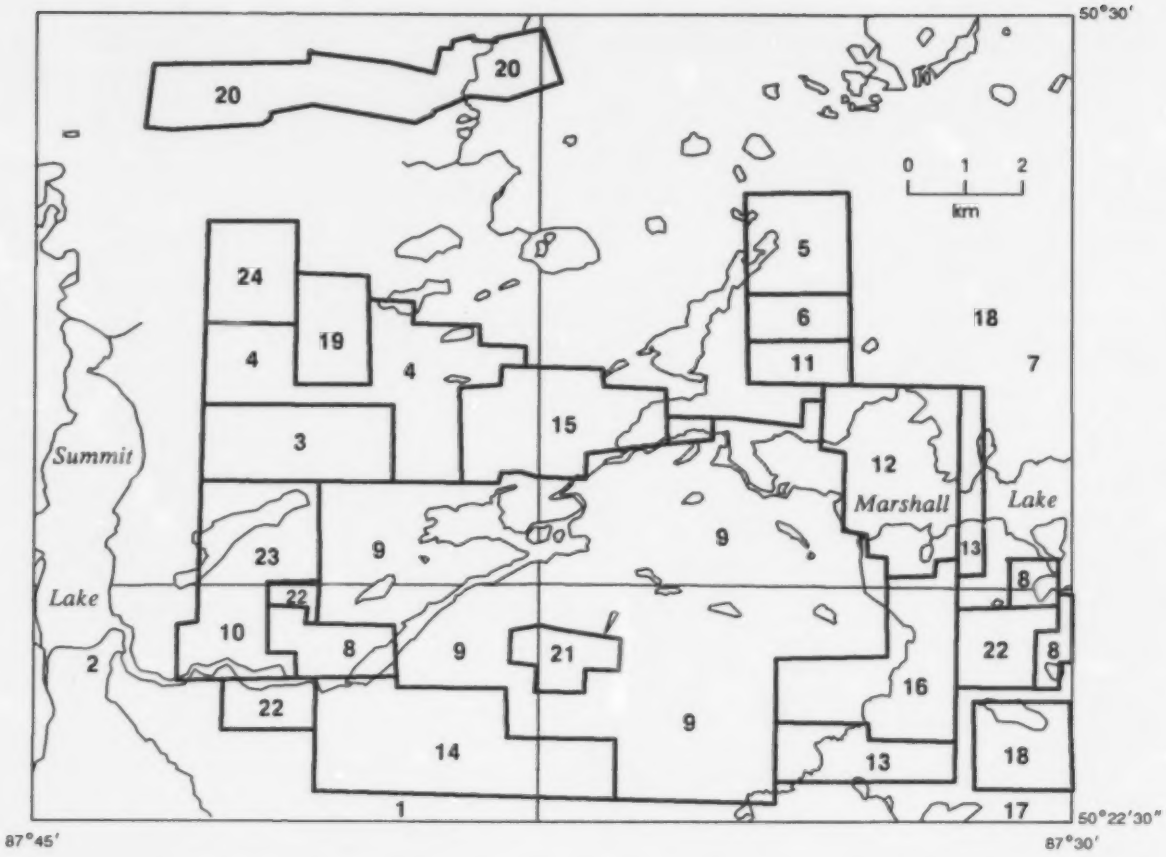

Figure 6. *Property location map (see Table 8 for list of properties).*

An electrical resistivity survey was carried out in the fall of 1955, but only a very minor variation in resistivity over the property was observed, and only a minor concentration of sulphides was indicated by this survey (N.B. Keevil, File 63.669, AFRO). No record of further exploration is available.

Rock outcrops are sparse in this area but the underlying units are interpreted to be tuffs and lapilli tuffs and associated finely laminated, cross-laminated and graded beds of volcaniclastics.

CONSOLIDATED MARBENOR MINES LTD. (1955) (2)

In 1955, Consolidated Marbenor Mines Ltd. owned a mining property (the area is not recorded in the files) located on the east shore of Summit Lake, at the mouth of the Gripp River. After a ground EM survey, several north-northwest-trending anomalous conductive zones were located. These conductors were tested by four diamond-drill holes totalling 678 m in length, that were collared in April of 1955. All of the holes intersected a shear zone in a granitic body, in which extensive caving occurred and resulted in poor core recovery. Considerable pyrite and traces of chalcopyrite (selected samples of which are reported to have returned 0.50 percent copper) was encountered between 126 and 157 m (AFRO; Resident Geologists Files, Ministry of Northern Development and Mines, Beardmore–Geraldton). The drilling was in the vicinity of the contact between diorite and trondhjemite of the Summit Lake stock and the metavolcanic rocks. The collars were not located by the field party, and no copper mineralization was observed in this locality.

COX, NOLAN (3)

Nolan Cox of Beardmore is the registered owner of 24 unpatented and unsurveyed claims numbered TB459253 to TB459276, inclusive, located just north of Lake "C". No exploration surveys have been filed and bedrock exposure on the property is poor.

DOUCETT, GEORGE (4)

George Doucett of Thunder Bay staked 50 unsurveyed claims numbered TB455767 to TB455786, TB464091 to TB464102, TB464306 to TB464309 and TB464312 to TB464325 all inclusive, immedi-

ately following the completion of the field mapping for this study, in the area between Summit, Phillips and Gripp lakes.

The property is extensively overlain by sand with only a few outcrops of metavolcanic rocks in the south.

DUCHENE, ROGER (5)

A block of 16 unpatented claims at the northeast end of Lake "A", numbered TB459313 to TB459328 inclusive, are registered to Roger Duchene of Jellicoe. Several trenches exposing pyrite-pyrrhotite mineralization near the top of the claim group were located during routine prospecting of the ground by the owner. Although these trenches were not located by the field party, several selected grab samples were donated by the owner. The location reported for these samples would appear to coincide with an anomalous aeromagnetic area just north of Lake "A" in the Toronto Lake aeromagnetic sheet (ODM–GSC 1963b).

In a selected grab sample from this property collected by the field party, the value of 34.9 percent total iron was returned (*see* Table 7).

FAYLE, RICHARD (6)

Richard Fayle is the registered owner of eight unpatented and unsurveyed claims numbered TB459489 to TB459496 inclusive, lying east of Lake "A". No rock outcrops were observed on the property, which is overlain by extensive and thick sand deposits and swamps. The ground is interpreted to be underlain by felsic fragmental volcanic rocks.

No record of any previous exploration surveys done on this ground is available in the Assessment Files Research Office, Toronto, or in the Resident Geologist's Files, Beardmore–Geraldton.

FEELEY, VINCENT (1965) (7)

In 1965, Vincent Feeley owned a parcel of land of unknown area 3 km north of Deeds Island. In this area, four surveyed claims, numbered KK24772 to KK24775 inclusive, have been allowed to lapse. Seven diamond-drill holes totalling 301 m in length were collared on the property in 1965 (AFRO). One of the holes intersected pyrite and pyrrhotite (with or without magnetite) in graphitic "hornblendite" and "gabbro" and six others cut graphite "quartzite" (most likely altered volcanics). No further surveys are reported in the area.

GALLEY, DAVID R. (8)

David R. Galley of Thunder Bay is the registered owner of two isolated blocks totalling 19 claims. The first group is located south of Deeds Island and consists of eight claims numbered TB459017 to TB459021 and TB458641 to TB458643, both inclusive, and the second lies north of the Gripp River, just west of the southern tip of Gripp Lake.

Several surveys have been conducted over an area of claims larger than those listed above in the Marshall Lake area that have included the former property. In 1962, Sheridan Geophysics Ltd. conducted MAG and EM surveys (File 63.1205, AFRO) that outlined several anomalous conductive areas, but no further exploration work was undertaken by this company. In 1955, Alator Corporation Ltd. conducted a resistivity survey, but no significant results were realized (File 63.674, AFRO). A large old trench about 3 m square containing pyrite-pyrrhotite-magnetite iron formation is exposed just west of the ferruginous chert on the headland, about 180 m south of Deeds Island. This iron formation occurs in contact with air-fall breccia and was reported by Langford (1959) to "appear to be part of a band of iron formation about 25 feet wide, which is partially exposed over a length of 120 feet. The sulphide is almost entirely pyrrhotite, with only a trace of pyrite (and magnetite). A close examination of the sulphide reveals that what appears as massive pyrrhotite is a mixture of fine-grained quartz and pyrrhotite. Small scattered patches and stringers of pyrrhotite become less common away from the main sulphide body." The pit is currently used as a garbage dump and was not easily accessible for sampling by the field party. Also in 1955, Silver–Miller Mines Ltd. carried out a resistivity survey in the area east of Deeds Island covering claims TB458641 to TB458643 (then KK24781 to KK24783). Five conductive zones were outlined (File 63.673, AFRO) but no further exploration work was undertaken. Still, in 1955, Yellowknife Bear Mines Ltd. conducted an electrical resistivity survey over a large part of this area. Five "good" resistivity areas were outlined (File 63.672, AFRO), but these zones were not apparently tested by drilling. No survey results are reported by the current owner.

The rock type of the claim group south of Deeds Island is almost exclusively air-fall breccia or a tuff breccia to pyroclastic breccia with a chloritic matrix and broken felsic fragments which are rimmed by mica- and amphibole-filled vesicles. The unit is interpreted to be a proximal product of source area "B" (*see* Map 2531, back pocket). At the point of land south of Deeds Island (claim TB459017), a laminated ferruginous chert containing magnetite-pyrrhotite-pyrite is exposed. This unit is interpreted to continue southwest into claim TB459019 and outside the property into Marshall Creek, with an apparent strike length and width of approximately 800 m and 50 m, respectively.

The second block of claims in the vicinity of Gripp Lake consists of eleven claims numbered TB459329 to TB459339, inclusive. No record of any exploration work is available, but several old trenches containing pyrite-pyrrhotite and traces of chalcopyrite were observed by the field party on the

north shore of Gripp Lake, in the area of old surveyed claims numbered KK26113 and KK26118.

The Gripp Lake group of David R. Galley is underlain by outcrops of intermediate to felsic tuff to lapilli tuff.

GIANT GRIPP MINES INC. AND IMPERIAL OIL LIMITED (9)

Giant Gripp Mines Inc. is a wholly owned subsidiary of N.W.T. Copper Mines Ltd. The parent company has been active in the area since 1968, when it acquired a part of the Billiton showing and a larger claim group in the vicinity of Marshall and Gripp lakes. The company acquired Kendon Copper Mines Ltd. property in 1970–1971 and hence full ownership of the entire strike length of the Billiton showing. Giant Gripp Mines Inc. was formed as a result of one of the option agreements between N.W.T. Copper Mines Ltd., and St. Joseph Explorations Ltd. in 1971–1972. When St. Joseph Explorations Ltd. dropped its option in 1975, N.W.T. Mines Ltd. signed an agreement with Imperial Oil Limited on October 1, 1975, in which the exploration arm of the oil company was to explore all that parcel of land (including the Billiton showing) that was owned by Giant Gripp Mines Inc. The details of the option agreement are not available, but according to the claim records some claims staked by the employees of the two companies were also included in the deal.

History of the Property

The Billiton showing was found as a result of the staking rush that was triggered by the discovery of copper-zinc mineralization by prospectors of Teck–Hughes Gold Mines Ltd. (now Teck Corporation Ltd.) in October 1954, about 1.2 km south of the east end of Gripp Lake (*see* discussion of Teck Corporation Ltd., Property No. 21). In 1955, the Billiton Company acquired some ground in the Marshall Lake area during the staking rush and excavated a few trenches on three separate showings, located about 0.8 km west of the junction between Marshall Lake and the Gripp River (Langford 1959, p.18), or just east of Lake "C" on the surveyed and leased claims KK22808 and KK23033. Probably because the demand for base metals eased off at the time (i.e., after the Korean war), most of the claims were allowed to lapse. Several owners have since acquired the Billiton showing as described in the following sections.

JACOBUS MINING CORP. LTD.

In 1960, the Billiton showings at the west end of Marshall Lake were re-examined. Between 1960 and 1962, Jacobus Mining Corp. Ltd. acquired 2500 acres of land (182 claims) lying west of Marshall Lake to Gripp Lake (Bayne 1970, p.4). According to R.V. Oja (January 19, 1969, p.3, File 63.2938, AFRO):

> ...the Billiton showings off the southwest end of Marshall Lake were re-investigated in the fall of 1960, and subsequent reconnaissance self-potential evaluation revealed an important anomalous zone about 700 feet long. The discovery of additional copper-zinc-silver mineralization associated with the self-potential anomaly precipitated another sequence of claim staking followed by diamond drilling of the main showing along with showings on other properties.

Between June and October, 1962, an ambitious diamond drilling programme involving a length of 3306 m over 64 holes, including some 9 m (30-foot)-spaced centres, was carried out (File 15, AFRO). This programme was supported by electromagnetic and magnetic geophysical exploration programmes conducted during the months of July, August and September, 1962 (File 63.R05, AFRO). Nineteen of these holes located by the present field party were surveyed by pace and compass methods from a drill road and the open pit on the main showing, and are shown on Figure 7 (holes M7, M19 to 32, M37 and 38, A9, A101). Because of scale, these 19 holes are shown by one drill hole symbol on Map 2531 (back pocket) to indicate their approximate position. The geophysical survey included an electromagnetic reconnaissance, with detailed electromagnetic and magnetometer surveys conducted over "structurally interesting and anomalous areas...in addition to detailed magnetometer and electromagnetic work conducted over the Main Showing Area", and was carried out by Sheridan Geophysics Ltd. According to J.P. Sheridan, (Nov. 27, 1962, File 63.1205, AFRO):

> The survey results...indicate a small conductor of poor to moderate conductivity located approximately coincident with the known major showing in the area. This showing has been extensively drilled and has been proven to represent a sulphide zone with interesting widths and values in zinc and copper. The anomaly representing this zone is small and indicates only poor to moderate conductivity. The poor to moderate conductivity indicated is indicative of the high percentages of sphalerite mineralization associated with this zone. The anomalous zone is shown geophysically to extend from Line 34W north-easterly to and possibly beyond Lines 26W (a strike-length of 800 feet). The major portion of this anomaly occurs between Lines 33W and 29W and is thought to represent the major portion of the known orezone. The size of this indicated anomaly is not sufficient to usually attract interest; however, in view of the results encountered in the drilling of this zone and in view of the poor conductivity known to be associated with the type of mineralization occurring in the area, other small poorly conducting zones must be considered to be of interest.

Sheridan Geophysics Ltd. also conducted geophysical surveys over portions of Jacobus Mining Corp. Ltd. ground in the vicinity of Gripp Lake, but apparently only poor to insignificant anomalies were outlined.

R.V. Oja (AFRO) used approximately 1200 m of diamond drilling in 26 holes, conducted on claim PA39206, to outline approximately 105 000 t of copper-zinc-silver-gold mineralization with an average grade of 1.37% copper, 5.91% zinc, 2.85 ounces

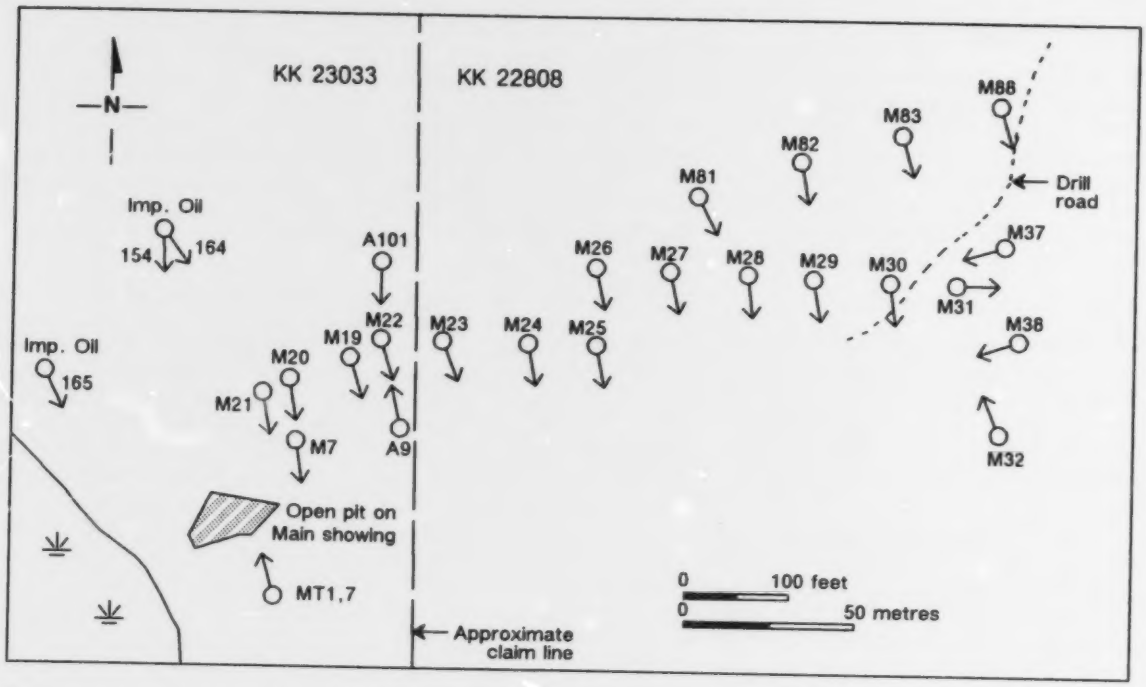

Figure 7. *Location of Jacobus Mining Corp. Ltd. drill program.*

per ton silver and 0.046 ounces per ton gold along a 500-foot strike length, and to a 9225-foot vertical depth at the east end only. According to Bayne (1970, p.4), "Toward the latter part of 1962, copper and zinc prices were down and zinc was in oversupply in world markets. Jacobus Mining Corp. Ltd. ran out of working capital and stopped work."

Exploration activity in the area apparently ceased at the end of 1962.

MARSHALL LAKE MINES LTD.

This company acquired the Jacobus property in 1963; in May of 1963 and again in July and August of 1967 it continued diamond drilling in the area around the main showing: holes 1 and 2 on KK24301 for 58 and 47 m (190 and 153 feet) respectively, May 1963; holes A16 and A17 on KK22798 for 225 and 229 m (748 and 752 feet) respectively, July 1967; holes A18 and A19 on KK24346 for 67.8 and 76.2 m (252 and 259 feet) respectively (File 15, AFRO). In 1965, the company drilled two more holes on the leased claims formerly owned by Min–Ore Mines Ltd., i.e., KK22753 (DDH 2 for 105 m) and KK24208 (DDH 1 for 100 m) in the Gripp Lake area (Resident Geologists' Files, Ministry of Northern Development and Mines, Beardmore–Geraldton). No economic base metal mineralization was intersected in the drilling.

MIN–ORE MINES LTD.

It is not known how much ground was owned by Min–Ore Mines Ltd. in the Gripp Lake area but in October, 1962, this company drilled eight holes (D1 to D8 inclusive) south of the south arm of Gripp Lake, totalling 382 m in length; five of these holes were on unsurveyed claim KK24208 and 3 were on leased claim KK22753. This ground was covered in the 1962 geophysical survey by Sheridan Geophysics Ltd. Records are available for six of these holes, and R.V. Oja reported light to heavy chalcopyrite and sphalerite in all six holes (Resident Geologists' Files, Ministry of Northern Development and Mines, Beardmore–Geraldton).

UNITED NEW FORTUNE MINES LTD.

According to J.P. Sheridan, (November 27, 1962, AFRO), this company owned a group of claims that was located immediately west of the Jacobus Mining Corp. Ltd. group, immediately north of Gripp Lake. A magnetometer and electromagnetic survey indicated conductive zones striking east-northeast across the property on claims KK24195 and KK24194 (now brought to lease). According to the Assessment Files Research Office, Ontario Geological Survey, Toronto, (File 16) a total of six diamond-drill holes (only four of whose logs are available, and total 514 m in length) were drilled in 1962 to test this zone, intersecting some chalcopyrite-sphalerite mineralization.

VINCENT FEELEY

In 1965, V. Feeley collared three diamond-drill holes totalling 14 m in length on claim KK26117 (TB404248), south of the south arm of Gripp Lake (File 19, AFRO). The three drill holes intersected minor base metal mineralization. Two other drill holes totalling 206 m in length were collared on claim KK22753 immediately to the north of KK26117 with similar results (File 20, AFRO).

REID MINING PROPERTIES

The Reid properties in 1967 consisted of two groups of leased mining claims, consisting of 33 claims at the southwest end of Marshall Lake and 12 claims at the northeast end of Gripp Lake (R.V. Oja, Aug. 15, 1968, Resident Geologists' Files, Ministry of Northern Development and Mines, Beardmore–Geraldton).

The properties were owned by George Reid of Toronto and the ground was probably acquired from, or in conjunction with, Marshall Lake Mines Ltd. Geophysical surveying consisting of magniphase and galvanic electromagnetic techniques and self potential and magnetometer surveys, and resulted in the detection of several additional anomalies south of the main shear zone on the property at the southwest end of Marshall Lake (R.V. Oja, AFRO). Two diamond-drill holes intersected sphalerite mineralization in "sheared quartzite (fragmentals) about 120 m south of the main shear zone in claim KK24346, and several holes were drilled under sulphide mineralization discovered on outcrops by prospecting and trenching about 600 m south of the main shear zone. Still another strong galvanic electromagnetic anomaly striking northeastward has been discovered about 1100 m south of the main shear zone. This latter anomaly is also covered by heavy overburden making trenching to discover the cause impractical." (R.V. Oja, AFRO).

Electromagnetic, magnetic and self potential surveys were also conducted over the entire Gripp Lake group, resulting in the discovery of several northeast-trending anomalies that were tested in 1962 by five diamond-drill holes. These indicated mineralized shear zones containing minor amounts of chalcopyrite, sphalerite and silver mineralization. (R.V. Oja, AFRO). A program of induced polarization surveying and deep drilling was recommended by R.V. Oja but no further information is available.

KENDON COPPER MINES LTD.

By 1968, the Billiton showing had come under two separate ownerships. Kendon Copper Mines Ltd. acquired the claims west of and including the leased claim KK23033 (now TB6422) and N.W.T. Copper Mines Ltd. owned that part of the showing located east of KK23033.

History of Exploration According to its Prospectus (AFRO), Giant Gripp Mines Inc. was incorporated on December 8, 1965, and by an agreement dated September 19, 1966, acquired 21 contiguous unpatented mining claims in the Gripp Lake area (Group 1) from John Joseph Daniel Filo of Toronto. Eight additional claims were acquired by the company (Group 2, Min–Ore prospect) on December 15, 1966, from J.J.D. Filo so that by December 1966, the company owned a 29-claim block in the Gripp Lake area (Groups 1 and 2) as outlined in Figure 8.

By an agreement dated February 19, 1968, and December 12, 1968, Kendon Copper Mines Ltd. acquired 11 contiguous unpatented mining claims (known as the Marshall Lake Property) from an unknown source (Group 3, Billiton Prospect) (Figure 8), and eight unpatented contiguous mining claims from Vincent Bernard Feeley (Group 4), both located in the Lake "C" area around the west end of the Billiton showing. Finally, by an agreement dated November 20, 1969, the company acquired 35 unpatented mining claims (Group 5) from J.J.D. Filo. The complete holdings of Kendon Copper Mines Ltd. by the end of 1969 consisted of 86 claims.

Geophysical Surveys A considerable amount of exploration work was carried out in the Marshall and Gripp lakes area properties of Kendon Copper Mines Ltd. According to D.W. Sullivan (Sept. 27, 1968, AFRO):

> Since April 1968, Kendon Copper Mines Ltd. (was) engaged in an exploration and development program on their Marshall Lake (and Gripp Lake) Properties.... Geophysical coverage, consisting of Induced Polarization surveys using the gradient array method, with subsequent 'three electrode' detailing (was) carried out over the Company's claims.

According to D.W. Sullivan (January 10, 1969, AFRO):

> Induced Polarization geophysical surveys (were) also carried out over the (property lying immediately south of the) original eleven claim property...where a base and precious metal sulphide body (was being explored by drilling)...on claim PA 39206 (KK23033) were successful in tracing the zone.... The survey outlined an important anomaly or anomalous zone on strike with the Kendon main sulphide zone (Billiton showing)....

A magnetic survey was also carried out over a limited area of the property, over the IP anomalous zones.

Diamond Drilling Considerable drilling had been previously done by other companies in parts of the property. For example, approximately 1402 m of shallow surface drilling over 26 holes was carried out by Jacobus Mining Corp. Ltd. in 1962 on claim PA39206 (KK23033), which outlined an interesting deposit of copper, zinc, silver and gold. Based on data obtained in the exploration program of Jacobus (R.V. Oja, AFRO), D.W. Sullivan (Sept. 27, 1968, AFRO) made a calculation that outlined 105 000 t of sulphide mineralization with an average grade of 1.37 percent copper, 5.91 percent zinc, 2.85 ounces per ton silver and 0.046 ounces per ton gold over a continuous length of approximately 152 m to a verti-

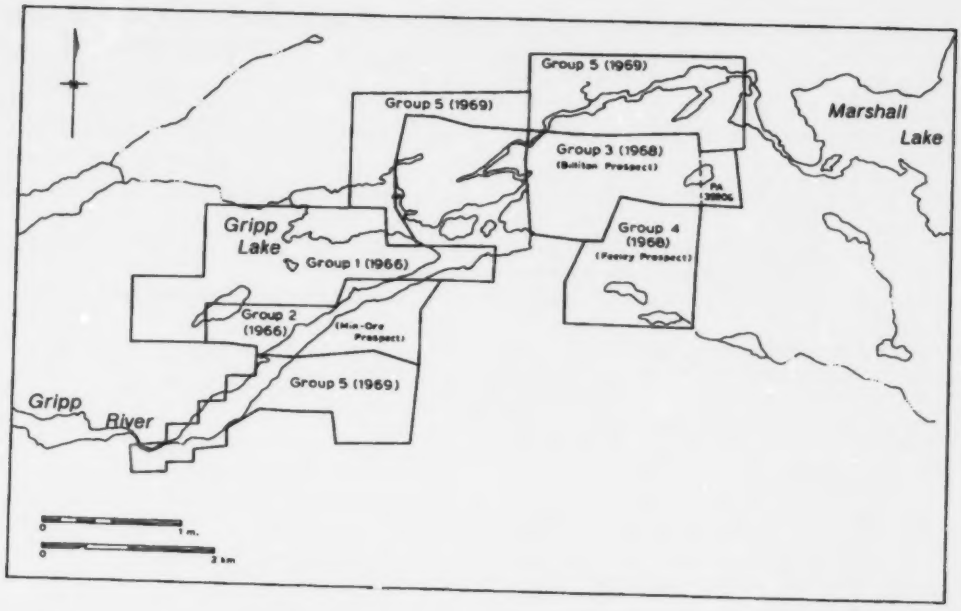

Figure 8. *Complete holdings of Kendon Copper Mines Ltd. acquired between 1966 and 1969.*

cal depth of 69 m, in the eastern section of the Billiton showing.

In the 1962 drilling of Min–Ore Mines Ltd. diamond-drill hole D-1 is reported in the Northern Miner to have cut 2.2 percent copper across 30 m of core length (D.W. Sullivan, Nov. 21, 1969, AFRO). This statement, however, is not corroborated by the available logs of D-1 where at most 22 m of fair to light copper-zinc mineralization, with only short lengths of heavy to massive copper-zinc mineralization was reported by R.V. Oja. However, no assay results were available to the author.

Up to September 1968, a total of 15 diamond-drill holes (K-1 to K-15 inclusive) were carried out on the main copper sulphide zone known as the "K" zone; additional drilling was done on this zone (K-16 to K-19) in 1970. The mineralization in the "K" zone was calculated by D.W. Sullivan (Nov. 21, 1969, AFRO) to contain 242 000 t of sulphide mineralization averaging 1.45 percent copper, 4.76 percent zinc and 2.8 ounces per ton silver along a 152 m (500 foot) strike length and to a 96 m (320 foot) vertical depth. The values were obtained by calculations utilizing the data of Jacobus Mining Corp. Ltd. surveys. A summary of the results of the drilling on the main or "K" zone is presented in Table 9.

Between August 1968 and November 1969, 11 holes totalling 1119 m in length were drilled on the "D" zone on claim PA39199 (now KK23028, or TB321313) in the western part of the property, immediately east of Gripp Lake (D.W. Sullivan, AFRO). D.W. Sullivan reported that one hole (D-5) cut 3.76 percent copper across 6 m of core length at a vertical depth of 55 m. However, D-6, drilled below D-5, cut only disseminated chalcopyrite, and the author suggests that it was collared below the plunge of the mineralization.

Between August 1968, and July 1970, over 50 drill holes totalling over 3700 m in length and designated according to the zone numbers, had been completed on seven zones, including the "D" and "K" zones. According to D.W. Sullivan (Nov. 21, 1969, AFRO):

> Three holes, m-1, m-2 and m-3 were drilled for a total of 1,111 feet (339 m) on the main or "K" zone to obtain samples for metallurgical testing and no further drilling was done on the "K" zone (after that). The testing of the "J" zone, on an I.P. anomaly was completed recently (Nov. 1969) with one diamond drill hole. This hole J-1 (on TB321718) returned an assay over one foot (0.305 m) of core running 2.6 percent copper and 0.38 ounces of silver, along with very minor values on either side of the intersection. Three holes S-1, S-2, and S-3 for a total of 757 feet (231 m) were drilled on a copper-zinc showing in the northeast corner of claim Pa39199 (now KK23028 or TB321313) ... Two other holes N-1 and B-1 (on TB321309) were drilled on sulphide showings with negative results.

Description of the Deposits The characteristics of the many deposits investigated by Kendon Copper Mines Ltd. are varied, but generally they are 1) confined to narrow shears (sericite schist zones), 2) closely associated with noses of minor folds where the mineralization is concentrated, and 3) marked by numerous gossan zones which are closely associated with garnetiferous amphibolite lenses composed of actinolite-tremolite, albitic plagioclase, white micas, biotite (Gripp Lake area), prochlorites, epidote, calcite and quartz.

TABLE 9. SUMMARY OF K-ZONE DRILLING ON KENDON PROPERTY (AFTER BAYNE 1970).

	Copper	Zinc	Silver
DDH K-1			
118.0' to 150.1' (32.1')	1.27%	3.07%	1.69 oz./ton
122.0' to 132.0' (10.0')	2.78%	6.61%	3.52 oz./ton
DDH K-2			
102.5' to 124.6' (22.1')	0.66%	4.02%	2.66 oz./ton
105.0' to 116.1' (11.1')	1.12%	7.85%	5.08 oz./ton
DDH K-3			
In the original hole, K-3A, core was lost or ground in the expected sulphide zone, and K-3 was drilled beside K-3A. Hole K-3 intersected base metal sulphides and assays are as follows:			
61.7' to 75.2' (13.5')	0.68%	5.48%	3.36 oz./ton
DDH K-4			
drilled under K-1 and A-1			
187.6' to 216.4' (28.8')	2.19%	2.39%	2.87 oz./ton
187.6' to 206.0' (18.4')	3.32%	3.40%	4.23 oz./ton
DDH K-5			
behind and under K-4			
203.7' to 243.0' (39.3')	1.82%	3.08%	2.88 oz./ton
203.7' to 224.2' (20.7')	3.01%	4.96%	4.83 oz./ton
DDH K-6			
drilled 50 feet southwest of K-5			
205.5' to 220.6' (15.1')	1.92%	1.72%	2.24 oz./ton
206.7' to 216.7' (10.0')	2.81%	2.55%	3.32 oz./ton
DDH K-7			
drilled behind and under K-5.			
228.4' to 266.2' (37.8')	1.91%	3.84%	3.61 oz./ton
228.4' to 247.1' (18.7')	3.71%	7.50%	6.70 oz./ton
DDH K-8			
drilled 50 feet northeast of K-5			
205.0' to 228.0' (23.0')	0.77%	2.69%	0.71 oz./ton
205.0' to 215.5' (10.5')	1.09%	5.36%	0.87 oz./ton
242.6' to 252.3' (9.7')	0.86%	5.62%	1.42 oz./ton
DDH K-9			
drilled behind and under K-7.			
268.5' to 304.0' (35.5')	2.07%	4.38%	4.01 oz./ton
268.5' to 286.5' (18.0')	3.78%	6.68%	7.04 oz./ton
DDH K-10			
drilled under K-9.			
280.4' to 309.6' (29.2')	1.29%	1.82%	2.04 oz./ton
280.4' to 298.0' (17.6')	1.90%	1.02%	2.86 oz./ton
DDH K-11			
drilled behind and under K-6.			
238.6' to 260.5' (21.9')	1.21%	2.48%	1.92 oz./ton
241.4' to 253.7' (12.3')	2.05%	4.16%	3.28 oz./ton
DDH K-12			
drilled 50 feet southwest of K-6.			
187.0' to 196.5' (9.5')	1.38%	1.23%	1.88 oz./ton
214.4' to 219.0' (4.5')	0.19%	1.64%	0.94 oz./ton
DDH K-13			
drilled 50 feet northwest of K-11.			
289.0' to 298.7' (9.7')	1.07%	2.20%	2.05 oz./ton
DDH K-14			
drilled 100 feet southwest of K-13.			
213.0' to 222.4' (9.4')	1.01%	3.87%	1.75 oz./ton
DDH K-15			
drilled 100 feet southwest of K-14.			
229.0' to 230.4' (1.4')	0.26%	4.72%	0.80 oz./ton

According to Bayne (1970) "utilizing the results obtained in these 15 holes, in combination with the previous drilling carried out by Jacobus Mining Corporation Limited the deposit outlined to date consists of 300,000 tons with an average grade as follows:

Copper	1.45%
Zinc	4.76%
Silver	2.8 ounces

Gold values are also present, however, all samples in the present drilling have not been assayed for this metal, as it is expected that the average value would be less than 0.05 ounces per ton."

DDH: Diamond-drill hole

The deposits will be discussed further on in the report under the current owners.

N.W.T. COPPER MINES LTD.

According to a report by Bayne (1970, p.iii), made available to the present author:

> By 1968–1969, NWT Copper Mines Ltd. acquired the 45 leased claims extending 0.4 km to 1.6 km (1/4 to 1 mile) west of Marshall Lake and 61 additional contiguous claims extending in the property 4 km (2.5 miles) further east.

This 106-claim ground included a portion of the Billiton showing east of claim KK23033 (or TB346422), that had been investigated by Jacobus Mining Corporation Ltd. (1960–1962), Marshall Lake Mines Ltd. (1962–1963; 1967) and G. Reid Mining Co. (1967).

Geophysical Surveys About 69 percent of the property was covered by geophysical surveys including a "Ronka EM 16" electromagnetic survey, an IP survey (to check EM anomalies), a magnetometer survey (over the main showing, and to trace the diabase dike) (R.V. Oja, February 19, 1969, AFRO). These surveys, together with surface prospecting and rock trenching, outlined major conductive zones consisting of varying amounts of base metal mineralization; in 1969, these were designated as follows: "103 zone" ("main zone" of Jacobus), "96 zone" (210 m south of the "main zone"), "83 zone" ("x zone" of Jacobus), "72 zone" (340 m south of the "x zone"), "66 zone" "(south zone" of Jacobus) (R.V. Oja, AFRO).

Diamond Drilling The "96 zone" was tested by N.W.T. Mines Ltd. holes 91 and 93 in 1969 and by holes 18 and 19 in 1967 (R.V. Oja, AFRO). The "83 zone" ("x zone") was tested by one X-ray hole in 1962. R.V. Oja (AFRO) has also reported:

> About forty-five diamond drill holes of which thirty are EX holes and the remainder AX were drilled over a length of 1,200 feet (369 m) from the west boundary of claim KK22808 eastward in the 1960–62 period and in 1967 periods of activity. A further twenty-four drill holes using standard A gear and BQ wire line equipment have been put down since October, 1968. Most of the work has been concentrated on the main "103"-zone where it is essential to gain further information of the downward projection or plunge of the mineralization. Twelve exploration EX holes...have been put down with the X-ray equipment on...(geophysical) anomalies...

Between 1968 and 1969 N.W.T. Mines Ltd. completed a total of 2459 m of diamond drilling on the "103 zone", the eastern extension of Kendon Copper Mines' main ("K") zone, and 722.7 m of preliminary testing of five other mineralized zones (Bayne 1970, p.iii). Up to April 30, 1969, a total length of 4877 m is reported to have been drilled on the main zone, (on the N.W.T. Copper Mines holding) to a maximum vertical depth of 277 m; only six holes, two drilled in 1967 and four during 1968–69, penetrated the zone below the 152 m (500 foot) level. "Over and above the drilling contracted by N.W.T. Copper Mines Ltd., a total footage of 232 m was accomplished by a company-owned x-ray diamond drill, which put down 10 holes in the area (183 m) 600 feet north of the base line on L24W and in the area immediately south of the main "103" zone, and north of the "96" zone." (R.V. Oja, AFRO).

In 1970, a feasibility study of the main zone ("103 zone") of N.W.T. Mines Ltd. was made by the consulting engineering firm of A.S. Bayne and Company. In the report of this firm, A.S. Bayne (1970, p.iii) stated the following (*see* Table 10):

> In the "103" zone, 49 of 51 drill intersections to date have cored economic grade of mineralization containing copper, zinc, lead, cadmium, bismuth, silver and gold across mineable widths up to (14.5 m) 47.6 feet. Five of the intersections are below the 500-foot depth.
>
> Recent estimates show a potential in "103"-zone, indicated and inferred by drilling between surface and the (304 m) 1,000-foot level, along 1,050 feet of strike length, of 1,174,810 tons. The weighted average metals content, calculated from 51 core intersections, is 0.82 percent copper, 2.71 percent zinc, 1.77 ounces per ton silver, 0.006 ounces per ton gold. The calculated average mining width, including a 15 percent waste wall-rock dilution allowance, is (3.4 m) 11 feet. Current (1970) metals prices show a gross value of $21.21 per ton in place. It is also estimated from recent assays of a composite sample of core from 10 typical drill cores, to contain at least 0.20 percent lead and 0.02 percent cadmium which, at current metals prices, raises the gross value by $2.20 to $23.41 per ton. The composite sample also assayed 0.01 percent bismuth which, if recoverable, would raise the gross value by a further $1.20 to $24.61 per ton.

Bayne (1970, p. 11-14) summarized other areas of mineral potential on the property of N.W.T. Copper Mines Ltd. as follows:

> ADDITIONAL POTENTIAL ... [of N.W.T. Copper Ltd.]...
>
> In addition to the main 103 Zone there are 9 mineralized zones on the property. Preliminary geophysical work, surface sampling and in a few cases, test drilling show 7 of these as good possibilities as indicated in the initial exploration of 103 Zone, in 1960–62.
>
> It should be noted that the 103 Zone contains an indicated 500 tons of economic grade per horizontal foot of strike length above the 500-foot level and a possible potential of 1,000 tons per foot of strike length above the 1,000 foot level. The 7 mineralized zones have been traced on surface for lengths of from 1,000 to 1,650 feet, or an aggregate of 9,850 feet.
>
> If further exploratory work on these 7 zones yields only 1/2 the tons per foot of strike length indicated in 103 Zone, at equal or even only a fraction of the grade (say $20.00 per ton), it would contribute an additional reserve of two to four million tons within economic operating distance of the main 103 zone.
>
> A detailed description of these additional zones follows.
>
> R-1 ZONE
>
> In 1969 a mineralized outcrop was found about 100 feet north of the 96 Zone conductor trace and about 200 feet south of the 103E Zone. A grab sample from a shallow rock pit assayed 0.55% copper, 3.10% zinc, 2.48 oz silver. A Ronka E.M. conductor trace passes just north of this showing about 200 feet south of the main 103 Zone and can be traced from the west boundary of KK 22808 for about 1300 feet east paralleling the main 103 E Zone.

TABLE 10. ESTIMATE OF TONNAGE AND GRADE, 103 (MAIN) ZONE. FROM BAYNE (1970).

INDICATED ABOVE 500' LEVEL	
Total strike length	1050 feet
Deepest core intersection	435 feet
Average depth of blocks	435 feet
No. of core intersections considered	51
Spacing of intersections along strike	25 to 200 feet
Average spacing along strike	91 feet
Spacing of intersections down dip	40 to 190 feet
Average spacing down dip	82 feet
Range of calculated mining widths	2.7 to 47.6 feet
Average mining width	10.2 feet
Total tons estimated	488 236 tons
INDICATED & INFERRED ABOVE 500' LEVEL	
Total strike length	1,050 feet
Deepest core intersection	545 feet
Depths of blocks indicated	435 feet
Average projection inferred to 500' level	65 feet
Inferred undrilled strike length (block E-27)	275 feet
- for inferred depth of -	130 feet
Average mining width	11 feet
Total tons estimated	571 749 tons
INFERRED 500' TO 1000' LEVEL*	
Total strike length	1050 feet
Intersections below 500' level	5
Vertical depths of intersections	520 to 870 feet
Spacing of intersection along strike	195 to 995 feet
Spacing of intersection down dip	55 to 250 feet
Average mining width	8.6 feet
Total tons estimated	449 825 tons

*Subject to further drilling below 500 feet

Following is a summary of the estimated potential tons and grade indicated and inferred along 1050 feet of strike length to a 1000-foot vertical depth....

	Estimated Tonnage	*Weight Average Grade* Cu (%)	Zn (%)	Ag (oz./ton)	Au (oz./ton)	*Gross Value†* ($/ton)
Surface to 500' Level:	571 749	1.01	3.68	2.12	0.010	$27.16
500' to 1000' Level:	449 825	0.86	2.40	1.94	0.003	$21.00
Total - Surface to 1000' Level:	1 021 574	0.95	3.10	2.04	0.007	$24.44

† 1970 prices: Cu @ $0.59/lb, Zn @ $0.15/lb, Ag @ $1.80/oz., Au @ $35.00/oz.

It is important to note that Hole A-14, drilled in 1962 by Jacobus Mining Co. Ltd. is located 450 feet east of this discovery. It was drilled south at 45 degrees to a total length of 541 feet. This hole intersected the main zone from 46.5 to 56.0 feet, averaging 1.11% copper, 1.98% zinc, 2.87 oz/ton silver and 0.056 oz/ton gold over 9.5-foot core length. The core throughout this hole, to the bottom, was in the bleached, sheared, sericitized, chloritized, silicified quartzite, typical of the environment of the main economic mineral deposit in 103 Zone. Medium banded dissemination, threads and blebs of sulphide mineralization occur in 1-foot to 4.6-foot core lengths of silicified, chloritized quartzite, alternating with lengths of highly sericitized core with sparse sulphides throughout the hole. At 391.5 to 393.5 feet, a 2.0-foot core length assayed 0.21% copper, 4.98% zinc, 5.22% lead, 3.65 oz/ton silver, 0.32 oz./ton gold. At current (1970) metals prices * this intersection indicates a gross value of $50.85 per ton in place.

R-1 Zone - Continued

Expanding this intersection to a greater width by averaging in the lower assay values for up to 6.7 feet into the walls, illustrates the following minewise alternatives:-

*1970 prices: Cu @ $0.59/lb, Pb @ $0.15/lb, Zn @ $0.15/lb, Ag @ $1.80/oz, Au @ $35.00/oz.

Core Length (feet)	Horiz. Width (feet)	Gross Value (5 metals) (per ton in place)
2.0	1.8	$50.85 per ton
4.0	3.6	$29.40
5.5	4.9	$22.13
6.7	6.0	$19.01
8.2	7.4	$15.78
9.5	8.5	$14.81

Projection of this intersection to plan shows that it is probably the easterly extension of the South Zone, as outlined by the E.M. conductor trace.

This important intersection, correlated with the surface exposure and the 1/4 mile long conductor, within 150 to 200 feet of the foot wall of 103 Zone, places the R - 1 Zone second in priority only to the former main deposit for further drilling...

96 (SWAMP) ZONE

This lies 700 feet south of the main 103 Zone near the north end of KK 24346. E.M. surveys indicated conductor traces striking north-easterly for 1,300 feet, swinging northerly for 350 feet and continuing northeasterly for 700 feet just north of the claim boundary. In 1967, Holes A18 and A19 were drilled south at 45 degr. es to 250-foot length cutting low values (up to 0.13% copper, 2.97% zinc over 5 feet) near the bottom of the holes. In 1968, Holes NWT 91 and 93 were drilled north at 45 degrees at the same sections. Hole 91 cut 8.8 feet, from 117.2 to 126.0 feet, averaging 0.16% copper, 1.18% zinc, 0.41 oz/ton silver. Hole 93 was abandoned at 233 feet owing to drilling difficulty due to fitchery (sic) rock due to fault conditions. Sections show the dip of the mineralized zone is north and that Holes A18 and A19 were stopped short of full cross-sectioning the conductive mineralized zone.

Also on Zone 96, just north of the boundary of KK 24346, where the conductor trace swings from northerly to northeasterly, six shallow (55 to 87-foot), 45-degree holes were drilled in 1968. Five holes (NWT-103 to NWT-107 inclusive) cut averages reported from 0.49% copper, 7.65% zinc, 2.41 oz/ton silver, over 2.1 feet to 0.35% copper, 2.19% zinc, 1.46 oz/ton silver over 11.5 feet. Hole NWT-116 was drilled south at 45 degrees to 482 feet. This hole could not possibly cut the conductor trace, bearing from 40 feet to 180 feet east of its northerly striking segment, but three narrow (6-inch) intersections averaging up to 0.32% copper, 3.55% zinc, 1.49 oz/ton silver are reported at 226, 247 and 367 feet.

The 1968 core logs of the holes generally indicate mineralization over longer core lengths than those sampled. For example in NWT-103, a 19-foot core length from 19 to 38 feet is logged as a mineralized zone, whereas only a 6-foot core length from 24.5 to 30.5 feet was sampled. This averaged 0.32% copper, 5.34% zinc, 1.60 oz/ton silver over the 6.0 feet.

During examination in August, 1970, the author of this report took "wing" or wall samples of the core from several holes, including NWT-103. A wall sample from 18.0 to 24.5 assayed 0.15% copper, 1.44% zinc, 0.72 oz/ton silver over the 6.5 feet of core. A 7.5 foot wall sample from 30.5 feet to 38.0 feet assayed 0.06% copper, 0.24% zinc and 0.36 oz/ton silver. The "minewise" economic importance of this more conclusive sampling is shown by the comparative total metals values following:-

1968: Sample $22.68/ton over 6.0-foot core length

1968-70: Samples $14.69/ton over 12.5-foot core length - or - $10.01/ton over 20.0-foot core length

Of the 2,350 feet of strike length indicated by the E.M. surveys, the preliminary drilling has intermittently explored only 420 feet. The excellence of the mineralization encountered warrants cross-sectional drilling, at 100-foot intervals, throughout the entire strike length, to at least 500 feet vertical depth."

83 ("X") ZONE

The 83 or "X" Zone lies 1,300 feet south of 96 Zone, on the south boundary of KK 24346. An E.M. conductor extends for about 1,000 feet along a northeasterly strike. One shallow drill hole put down in 1962 intersected 3.5 feet assaying 4.17% zinc and 4.12 oz/ton silver. No further work has been done on this zone, except that the Ronka 16 E.M. and an induced polarization (I.P.) survey outlined anomalies coinciding with the 1962 magniphase E.M. conductor. The results of the preliminary tests of this zone also warrant cross-sectional drilling at 100-foot intervals throughout its strike length.

Overburden prohibits surface sampling of the 96 Zone and 83 Zone, but on August 17, 1970, the author of this report examined an outcrop of sheared sediments about 300 feet south of 96 Zone and 1,000 feet north of 83 Zone, on the west half of KK 24346. An outcrop about 30 feet wide is exposed by stripping, showing sheared, crenulated silicified quartzite striking northeast. About 200 feet north of this, a blast on the west side of a low (10-foot) bluff, the shearing strikes almost north and south. A 10-pound composite of 6 random grab samples assayed 1.20% copper, 2.44% zinc, 1.62 oz/ton silver, 0.01 oz/ton gold, 0.01% cadmium, 0.005% bismuth.

72 ZONE

This zone lies about 1,100 feet south of 83 Zone. An E.M. conductor trace strikes northeasterly from the middle of KK 24347 to the north half of KK 23035. On KK 23035 the 1968 maps show pits in gossan with copper and zinc sulphides. In 1968, Hole NWT-111 drilled north at 45 degrees near the west end of the conductor trace, cut highly altered, sheared and probably faulted quartzite, with low copper-zinc mineralization. An I.P. survey showed weak chargeability in parts of the zone, which warrant further drilling.

66 ZONE

This zone lies 600 feet south of 72 Zone. A series of E.M. Conductor traces crosses the south boundary of KK 24347, striking northeasterly for 1,600 feet. Holes 112 and 113 drilled in 1968 to 266 and 86 feet respectively, cut a highly fitchery fault zone with minor copper and zinc mineralization.

The E.M. surveys tracing Zones 66 and 72 appear to reflect highly sheared or faulted zones with some copper and zinc sulphides. These zones should be further detailed by a geochemical soil analysis survey and by long wire galvanic electromagnetic technique. Test drilling should be done by "BQ" wire-line equipment.

SOUTH ZONE

A strong conductor trace was located by the E.M. Magniphase survey in 1960-62, cutting across the northwest corner of KK 23036, over a length of 1,500 feet along a northeast strike. This parallels a strong fault shown on Map 1958-1, about 1/4 mile to the southeast. No work has been done on this zone, which should be drilled.

RIVER ZONE

Induced polarization I.P. equipment was used in 1968-69 to test electromagnetic conductors. The strongest I.P. anomalies were detected at the outlet of Marshall Lake near the camp. Holes NWT 117, 118 and 119 were drilled from the shore, but failed to cut sufficient sulphide mineralization to account for the I.P. anomaly.

NORTHEAST ZONE

At the northeast corner of the property the E.M. and magnetometer surveys outlined a major series of conductors

striking northeast for 3/4 mile across KK 28154, 28155, 204279, 204282 and 204281, in a band from 400 to 600 feet wide. It lies along the south rim of a high magnetic anomaly created by underlying rocks indicated to be a complex of basic intrusive igneous rocks, by outcrops observed along the north shore of Marshall Lake, 1-1/2 miles south.

Three minor conductors were also outlined (See 'A', 'B', 'C' on the enclosed map). A short (30' to 50') hole was drilled with a small 'X-Ray' drill at these sites. The core, which was recovered with difficulty, contained pyrrhotite with minor chalcopyrite and sphalerite in a mixture of amphibolite and quartzite.

No work has ever been done on the large conductive area to the north, which lies under overburden and will require large drilling equipment. The high conductivity of this area, coinciding with the aerial magnetic anomaly, warrants cross-sectional drilling of holes from 500 to 1,000 feet in length, equipped for recovery of core of at least 1-1/4 inch diameter.

NORTH ZONE

In 1969 a relatively new zone of mineralization was discovered, just east of the diabase dyke, about 1200 feet north of the main 103E zone on Line 24W. A grab sample (See R-2...) assayed 0.25% copper, 3.07% zinc, 21.75 oz/ton silver. Nothing further was done on this zone until August, 1970, a discovery was made by N.W.T. Copper Mines near the west boundary of KK22808 about 700 feet north of the main 103 Zone. Blasting for about 2 feet below surface disclosed an outcrop about 40 feet wide. A well sheared and crenulated quartzite was well mineralized by chalcopyrite, sphalerite and pyrite. A 10-pound sample taken by the author of this report at random from various points across 20 feet, assayed 1.52% copper, 1.60% zinc, 3.30 oz/ton silver, 0.02 oz/ton gold, 0.005% cadmium (See B-20 ...). During September the N.W.T. prospectors reported having traced this zone almost to the Gripp River, for about 1,500 feet northeast of B-20, by a series of shallow rock blasts in mineralized outcrops. This zone warrants further work.

GONZALES, CECIL

In 1973, Cecil Gonzales of Toronto owned an unknown number of claims in an area about 1219 m south of the camp, on the south shore of Marshall Lake. Two diamond-drill holes, 119 m and 33 m in length, were drilled on claims TB329119 and TB329115 (now TB407464), respectively, by Pelky Bros. Ltd. of Algoma Mills between May 27 and June 3, 1973. Credit for this survey (500 days) was applied to 18 contiguous claims in the area (File 23, AFRO). Although no significant sulphide intersections were indicated in the core logs, a pronounced gossan zone and numerous trends indicating a wide pyrite zone development in the current claims TB407464, KK24306, TB407467 and TB329119 (now owned by Giant Gripp Mines Inc.–Imperial Oil Limited) were mapped by the present field party.

GIANT GRIPP MINES INC.–ST. JOSEPH EXPLORATIONS LTD.

In 1973, St. Joseph Explorations Ltd. optioned 45 leased claims from N.W.T. Copper Mines Ltd. and staked an additional 31 claims. All of these claims were subsequently transferred to a holding company, Giant Gripp Mines Inc., which was formed by N.W.T. Copper Mines Ltd. and St. Joseph Explorations Ltd. for the sole purpose of exploring and developing this property. The 76-claim block covered the entire strike length of the Billiton showing because by this time, N.W.T. Copper Mines Ltd. had acquired that part of the Billiton showing west of claim KK22808 that was previously owned by Kendon Copper Mines Ltd. between 1965 and 1977.

Geophysical Surveys In 1973, St. Joseph Explorations Ltd. completed a magnetometer survey over all of the property south of the Gripp River (File 2.122, AFRO); this includes partial resurvey of the property with a Scintrex Se-700 Turam instrument. Geological mapping and a B Horizon soil geochemistry survey were also completed (H.L. King, May 1974, AFRO). The magnetic survey was unsuccessful, as only a weak (100 gamma) magnetic anomaly could be correlated with the mineralized zone, west of the diabase dike and the two sets of faults in the area (Peter T. George, File 2.1222, AFRO). According to L.G. Closs (Ontario Geological Survey, personal communication, *circa* 1977), the Turam survey provided inconclusive results. The geochemical survey was technically successful, but no further work was done.

In January 1974, the geophysical grid was extended to include additional ground to the south and east of Gripp Lake. A horizontal loop EM survey and VLF–EM survey were conducted on the ground during the months of January, February and March, 1974, over the extended grid. H.L. King (File 2.1750, AFRO) concluded that, "The horizontal loop survey has eliminated the presence of any large, near-surface, massive sulphide bodies within the area surveyed. However, the survey did not properly delineate the (known) mineralization characteristic of the main zone." The VLF survey outlined a large number of anomalous zones. Even though most of the anomalies were coincident with topographic features, the survey successfully outlined the main showing of known copper-zinc-silver mineralization by a relatively strong VLF anomaly located between L35W and L24W (H.L. King, AFRO).

Diamond Drilling A programme of diamond drilling was recommended following the VLF survey, and although 18 holes totalling 1219 m in length were planned for 1974 and were just being completed by June 22, 1974 (L.G. Closs, Ontario Geological Survey, personal communication, *circa* 1977), a record of only 12 holes totalling 734 m in length is available in Files 24, 25, 26 and 27 (AFRO). Although some sulphide mineralization was intersected in the drilling, no significant amounts of base metals were outlined. Apparently no follow-up drilling was conducted on the main showing, where a relatively strong VLF anomaly was located. St. Joseph Explorations Ltd. dropped its option on the property in 1975, and the claims resorted back to Giant Gripp Mines Inc., which then became a wholly owned subsidiary of N.W.T. Copper Mines Ltd.

MCDERMOTT, JOSEPH

Work including rock pit mining, and mechanical and manual labour has been filed for assessment by Joe McDermott of Toronto for several localities in the area, more specifically on the N.W.T. Copper Mines Ltd. and Giant Gripp Mines Inc. properties between 1974 and 1975.

During this period, Joe McDermott also collared 11 diamond-drill holes totalling 616 m in length (Files 28 and 29, AFRO). These holes were located on claims TB26116, KK22753 and TB404244 ("lease showing") in the Gripp Lake area, and on claim TB321725 ("open-pit" showing) in the Lake "F" area, astride the most predominant fault in the map area (File 29, AFRO).

IMPERIAL OIL LIMITED

On October 1, 1975, Imperial Oil Limited entered into an option agreement with Giant Gripp Mines Inc. (by then a wholly owned subsidiary of N.W.T. Copper Mines Ltd.) to investigate a large block of claims (111 contiguous claims) in the Gripp Lake–Marshall Lake area. This block of claims included all of the main or Billiton showing and the other major showings of N.W.T. Copper Mines Ltd., showings locally known as: "diabase", "north main", "cabin area", "lease", "open pit" and "new zinc" showings. By the end of the current field mapping survey, the grounds that were registered to various individuals (some of whom were employees of the two companies) at the beginning of the field season had been added to the Giant Gripp Mines Project of Imperial Oil Limited (*see* Property No. 9, Figure 6).

Exploration Surveys During the winter months of 1975, a new geophysical grid consisting of approximately 80 km of line was cut over most of the Giant Gripp Mines–Teck Corporation options by Imperial Oil Limited. This grid was extended eastwards during the 1977 field season.

Between May and September of 1976, a five-man geological party conducted a detailed survey of the western half of the property and reconnaissance mapping of the eastern half. While the geological survey was in progress, the entire Giant Gripp Mines–Teck Corporation option groups were systematically prospected with particular attention to gossan zones by a prospecting crew led by Walter N. Baker, one of the discoverers of the original Teck showing in 1954 (AFRO). Besides accurately recognizing the volcanic fragmental and pyroclastic nature of the rocks, the combined endeavour of the geological and prospecting crews exposed (by trenching) several new mineralized zones (showings), the most significant of which were locally called: "G-1", "G-2", "Gazooma", "406 Hill", "Cherry Hill", "Teck Hill" (*see* Map 2531, back pocket), "Pelky's Highway" and "New Copper". Chalcopyrite-bornite mineralization from the "G-1" zone was reported in 1976 ("The Northern Miner", July 29, 1976, p.1; *see also* Amukun 1977a, p. 83). Some of these and a few of the old showings were selectively grab-sampled by the current field party.

During the period June 4 to July 16, 1976, an induced polarization (IP) survey was conducted over the entire grid using a McPhar Geophysics Frequency Domain IP Unit (AFRO). Several "very good" and "good" conductors were outlined in the survey and defined the major targets for the 1977 diamond drilling program. A part of this survey and its results (34.4 line kilometres) was submitted for assessment credit (AFRO). During the 1977 field season, additional electromagnetic (EM) surveys were being conducted on the eastern extension of the grid, between Marshall Lake and the little lake located 600 m south of the large island at the west end of Marshall Lake (lines O to 42E and the extended base line). The results of this survey were unavailable to the author.

Beginning in January 1977, Imperial Oil Limited embarked on an extensive diamond drilling program which at time of writing had included 27 holes totalling 36 100 m in length (A.S. Bayne, N.W.T. Copper Mines Ltd., personal communication, 1977). Eighteen of these holes collared as of August 1977 and totalling 1967 m in length have been submitted for assessment credit (files 30 to 33 inclusive, AFRO). The positions of the 18 holes are shown in Figure 9 and the descriptions of the mineralized intersections are summarized in Tables 11 and 12.

HIBBART, NICK (10)

Nick Hibbart of Thunder Bay is the registered owner of a group of 15 claims numbered TB459380 to TB459390 and TB458810 to TB458813, both inclusive, north of Gripp River and south of Lake "C", adjoining the David R. Galley property (8). No record of any exploration work conducted on this ground is available.

The property is predominantly covered by swamp deposits, but a few outcrops of gneissic and unsubdivided felsic metavolcanics, intermediate to felsic tuff to lapilli tuff and porphyritic diabase dike are exposed.

JOHNSON, DON R. (11)

Eight claims numbered TB458481 to TB459488, inclusive, are registered in the name of Don R. Johnson of Thunder Bay in the area east of Lake "A". The property is extensively covered by thick Pleistocene sand deposits and is probably underlain by felsic volcanic fragmental rocks

KASNER, R.J. (12)

At the beginning of the field season, R.J. Kasner of Kirkland Lake was the registered owner of three groups of claims located in the Gripp and Marshall lakes areas (*see* Figure 6). The two groups in the Gripp Lake area numbered TB44116 to TB446124

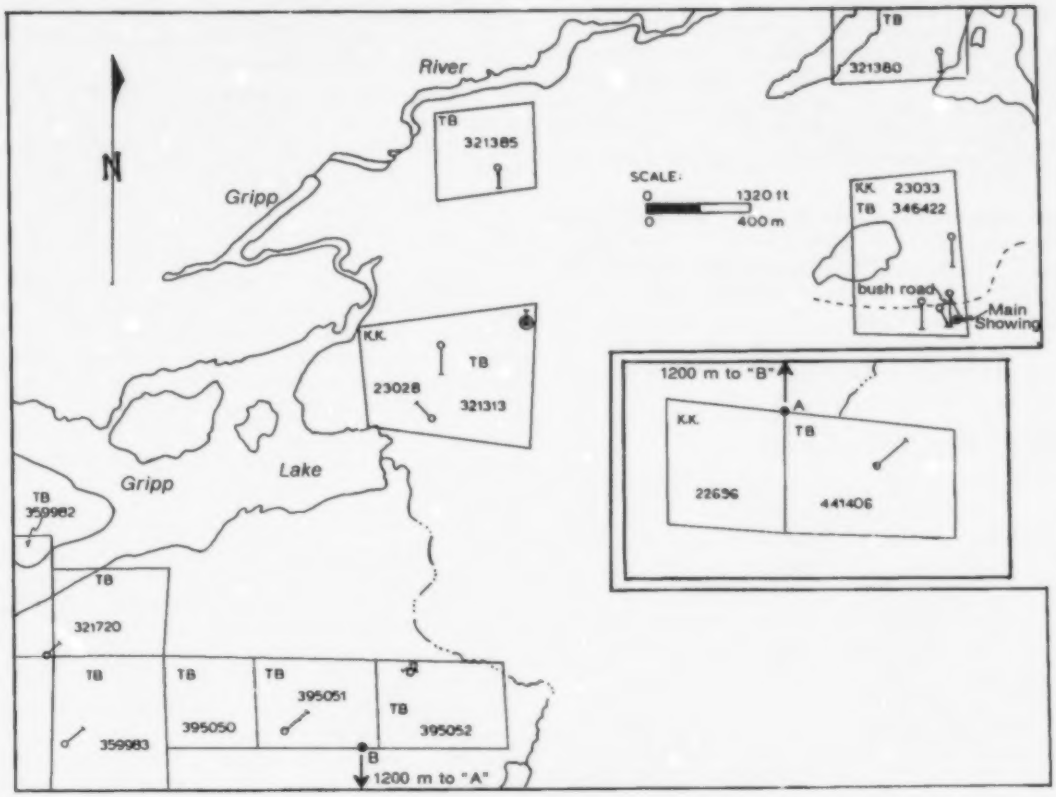

Figure 9. *Location of Giant Gripp Mines Ltd.–Imperial Oil Limited drill program.*

and TB442474 to TB442479, both inclusive and TB442090 to TB442104 inclusive, were transferred to Imperial Oil Limited–Giant Gripp Mines Inc. (Property No. 9). The remaining block consists of 39 claims numbered TB476903 to TB476941, inclusive, and covers most of Marshall Lake between Dog Island and the group of islands just northeast of the camp.

No record of previous exploration surveys is available, but Langford (1959) reported a pit in which sulphides were exposed, in the area about 1.6 km north of the group of islands. This pit was not located by the field party, but numerous outcrops of a reddish-weathering gabbroic dike rock containing disseminated pyrite were observed in the area. Several exposures of a coarse-grained hornblende gabbro body occur on the shore of Marshall Lake, about 1.6 km northeast of the group of islands. This rock is invariably magnetic and contains magnetite, pyrrhotite and pyrite. This iron oxide/sulphide mineralization is interpreted from aeromagnetic data to extend northeast for 2.0 km, where it was intersected at depth in the 1968–1969 drilling of N.W.T. Copper Mines Ltd. (AFRO). Selected grab samples collected by the field party were analyzed for total iron; the results are presented in Table 7 (numbers 45 and 46).

The geology of the property can be subdivided into three mappable assemblages. The area on the northeast shore of Marshall Lake is essentially underlain by pillowed intermediate to felsic flows and flow breccias that contain distinct amygdaloidal or spherulitic zones of kyanite + andalusite + cordierite alteration (*see* discussion on metavolcanics). Pillowed intermediate to felsic flows are also exposed on the south shore of Marshall Lake, east of Marshall Creek. The area around Dog Island and the south shore of Marshall Lake consists of two distinct types of coarse fragmental metavolcanic rocks of unknown origin, but because of the chloritic matrix and because of broken chloritic fragments, the airfall breccia on the south shore may also be attributed to either a lahar or a mud flow. The two types of metavolcanic rocks have been intruded by hornblende gabbro in the northeast corner of the property.

LILL, JOHN R. (13)

John R. Lill of Scarborough, Ontario, owns two blocks with a total of 28 contiguous surveyed claims

TABLE 11. SUMMARY OF DIAMOND DRILLING RESULTS, GIANT GRIPP MINES LTD.-IMPERIAL OIL LIMITED, JANUARY-AUGUST 1977 (ASSESSMENT FILES RESEARCH OFFICE, ONTARIO GEOLOGICAL SURVEY, TORONTO).

Hole No.	Claim No.	Intersection (feet)	Mineralization	Comments
153	TB346422 (KK2303)	155-167.5	0.18 percent copper; 0.38 percent zinc, 0.42 oz./ton gold; trace silver	
154	TB346422 (KK23033)		*see* Table 15b following	testing IP anomaly in the main zone.
161	TB346422 (KK23033)	232.5-244.0	trace gold; trace silver	testing IP anomaly
164	TB346422 (KK23033)	219.5-244.5 275.0-303.0	-stringers and seams of sphalerite; visual estimate 1-2 percent sphalerite chalcopyrite each, no assay values reported -top 3 feet 20 percent chalcopyrite, 10 per cent sphalerite	testing main zone
165	TB346422 (KK23033)	171.0-173.5	-visual estimate 5 percent sphalerite and chalcopyrite each	
		174.0-185.0	-stringers and disseminated sphalerite-chalcopyrite	
		201.0-202.5	-few sphalerite stringers	
158	TB321380	349.-354	-disseminated and stringer chalcopyrite throughout hole; "good splashes" of chalcopyrite.	testing IP anomaly
159	TB321380		minor chalcopyrite near end of hole	
160	(KK23028) TB321313	136-143	disseminated chalcopyrite, not assayed	testing IP anomaly
167	(KK23028) TB321313	36.0-41.0	-0.07 percent copper, 0.16 percent zinc, trace gold	testing high grade zinc showing
		53.0-68.9	-0.06 percent copper, 0.56 percent zinc, 0.02 oz./t gold	
		134.0-135.0	-0.08 percent copper, 0.07 percent zinc, trace gold	
168	(KK23028) TB321313	60.0-64.0	-0.04 percent copper, 0.16 percent zinc, trace gold	testing high grade zinc showing
		66.8-67.8	-0.02 percent copper, 0.31 percent zinc, trace gold	
		75.8-76.8	-trace copper, 0.03 percent zinc, trace gold	
169	(KK23028) TB321313	99.5-120.8	-0.65 percent copper, trace to nil silver and gold	testing IP anomaly
		124.0-135.0	-0.82 percent copper, trace to nil silver and gold	
		166.7-171.7	-0.31 percent copper, trace to nil silver and gold	
		179.5-204.5	-0.46 percent copper; trace to nil silver and gold	
		231.0-362.5	-0.14-0.94 percent gold in isolated 2-foot sections	

TABLE 11. CONTINUED.

Hole No.	Claim No.	Intersection (feet)	Mineralization	Comments
171	TB359982	21.0-25.0	-0.62 percent copper, 0.01 percent zinc, trace to nil silver and gold	testing "lease" showing along strike
		59.0-66.0	-0.55 percent copper, 0.02 percent zinc, trace to nil silver and gold	
		221.0-224.0	-0.19 percent copper, 0.01 percent zinc, trace to nil silver and gold	
		241.0-242.0	-0.35 percent copper, 0.01 percent zinc, trace to nil silver and gold	
172	TB359983	307.0-314.5	-0.80 percent copper; 0.02 percent zinc; trace silver and gold -0.53 percent copper; 0.02 percent zinc	testing iron formation anomalies south of "lease" showing
173	TB395051	227.0-232.0	-0.15 percent copper zinc, trace to nil silver and gold	testing IP anomaly
		495.0-505.0	-0.13 percent copper, 0.02 percent zinc, trace to nil silver and gold	
		527.0-532.0	-0.14 percent copper, 0.01 percent zinc, trace to nil silver and gold	
		552.5-562.5	-0.28 percent copper, 0.02 percent zinc, trace to nil silver and gold	
174A	TB395052	4.0-10.0	-5.60 percent copper; 1.48 percent zinc; 3.77 oz./ton silver; 0.024 oz./ton gold	testing "G-1" showing
		11.7-13.0	-6.26 percent copper, 0.88 percent zinc, 3.96 oz./ton silver; 0.02 oz./ton gold	
174B	TB395052	5.0-14.0	-5.78 percent copper; 1.75 percent zinc; 3.58 oz./ton silver; 0.01 oz./ton gold	testing "G-1" showing
174C	TB395052	63.0-65.0	0.48 percent copper; 0.07 percent zinc; 0.26 oz./ton silver; trace gold.	testing "G-1" showing
		78.0-80.5	-0.65 percent copper; 0.04 percent zinc; 0.34 oz./ton silver; trace gold.	
		103.0-184.5	-0.17 percent copper; 0.05 percent zinc; 0.01 oz./ton silver; trace gold.	
		148.0-172.0	-0.30 percent copper; 0.04 percent zinc; 0.17 oz./ton silver; trace gold	
181	TB441406	210-227	-assays not reported; disseminated chalcopyrite and sphalerite.	testing "406 Hill" testing IP anomaly
		262-320	-assays not reported; isolated stringers disseminations of chalcopyrite and sphalerite	
		506-519.5	-assays not reported disseminated shalerite, chalcopyrite; galena disseminations near end of section	

TABLE 12. SUMMARY OF COLLAR INTERSECTIONS OF MINERALIZATION FOR HOLE 154, BY IMPERIAL OIL LIMITED (RESIDENT GEOLOGISTS FILES, ONTARIO MINISTRY OF NORTHERN DEVELOPMENT AND MINES, BEARDMORE-GERALDTON).

INTERVAL	Width	Cu (%)	Cu (weight %)	Zn (%)	Zn (weight %)	Ag (oz./ton)	Weight Average
275.5-280.5	5.0	1.6	8.35	10.3	51.50	0.08	45.40
280.5-285.5	5.0	1.79	8.95	2.75	31.75	2.52	12.60
285.5-290.5	5.0	1.57	7.85	1.04	5.20	1.70	8.50
290.5-295.5	5.0	2.55	12.75	2.06	10.30	3.72	18.60
295.5-300.5	5.0	0.30	1.50	0.29	1.45	0.30	1.50
300.5-305.5	5.0	0.50	2.50	0.76	3.80	0.60	3.00
305.5-310.5	5.0	0.28	1.40	0.39	1.95	0.22	1.10
310.5-314	3.5	0.17	.60	4.55	15.93	0.30	1.05
275.5-314	38.5	1.14	43.90	2.70	103.88	2.38	91.75
275.5-305.5	30.0	1.40	41.90	2.87	86.00	2.99	89.60
275.5-295.5	20.0	1.90	37.90	4.03	80.75	4.26	85.10

Note: Alternate widths of 38.5', 30.0' and 20.0' and corresponding grades of 1.14% Cu, 2.70% Zn, 1.40% Cu, 2.87% Zn; and 1.90% Cu, 4.03% Zn are presented.

numbered TB477136 to TB477143 and TB477116 to TB477135 (both inclusive) in the Marshall Lake area. The first block consists of a one-claim-width strip made up of eight claims that border the east edge of the Kasner property (12). The second group consists of 20 contiguous unsurveyed claims located astride Marshall Creek to the west of Lake "B" (*see* Map 2531, back pocket), north and northwest of Little Marshall Lake.

In 1968–69, N.W.T. Copper Mines Ltd. conducted a diamond-drilling program in the area to the north of and including part of the former claim group. Three of the 12 collars were located on claim TB477136. This drilling intersected pyritiferous schistose metasediments and metavolcanics with no significant profitable sulphides. The latter claim group covers most of the Prospectors Airways Co. Ltd. prospect of 1955, which at that time consisted of 36 contiguous claims that adjoined the east border of the Teck Corporation property (then known as Teck–Hughes Gold Mines Ltd.).

History of the Prospectors Airways Co. Ltd. Prospect

The 36-claim group then numbered KK8306 to KK8341, inclusive, of Prospectors Airways Co. Ltd. of Toronto was known as the Rip Property (option). Because approximately 95 percent of the area of the claim group was covered with overburden, geophysical methods were considered to be the best means to explore the ground (L.J. D'Aigle, September 30, 1955, File 63.646, AFRO). Between February 24 and April 11, 1955, a grid was cut over the entire property; magnetometer and electromagnetic surveys were conducted between March 1 and April 18. Several strong conductors striking 060° were outlined by the surveys. The strongest conductors were located south of Marshall Creek, where two zones approximately 213 m apart were nearly parallel for over a length of 670 m. The northernmost zone was offset between lines 21+00E and 16+00E by a sharp fold or cross fault with an apparent total offset of 43 to 49 m; the southernmost zone extended for a distance of 1463 m between lines 21+00E and 18+50E, where it terminated abruptly (L.J. D'Aigle, 1955, AFRO) (*see* Figure 10). On the basis of geophysical survey results, a diamond-drilling program was recommended to test the anomalous zones at depth.

A total of eight diamond-drill holes numbered R1 to R8 and totalling 915 m in length were collared. One of these holes (R7) was located on claim KK8314, north of Marshall Creek (Property No. 16); six others were located south of Marshall Creek on Property No. 16 (Figure 10). A summary of the drill results submitted by L.J. D'Aigle (File No. 13, AFRO) is presented in Table 13. The geology of the property consists of distal subaqueous pyroclastic deposits with distinct and conformable (?) volcaniclastic and chert horizons. Several faults defined by crushed rock, fault breccia and steep topographic ridges are located on the property, north of Marshall Creek.

LYNX–CANADA LTD. (14)

Lynx–Canada Ltd. is now the registered owner of 52 contiguous unsurveyed claims, which at the beginning of the 1977 field season were registered to D. Thorsteinson and M.I. Watson. These claims are located south of the west end of Gripp Lake.

There was no record of exploration work conducted by Lynx–Canada Ltd. to date, but it is known by the author that some exploration work was planned before the 1977–1978 freeze-up, and that during the 1977 field season D. Thorsteinson conducted trenching and surface exploration on the northeast part of the claim group where disseminated chalcopyrite mineralization was exposed in the

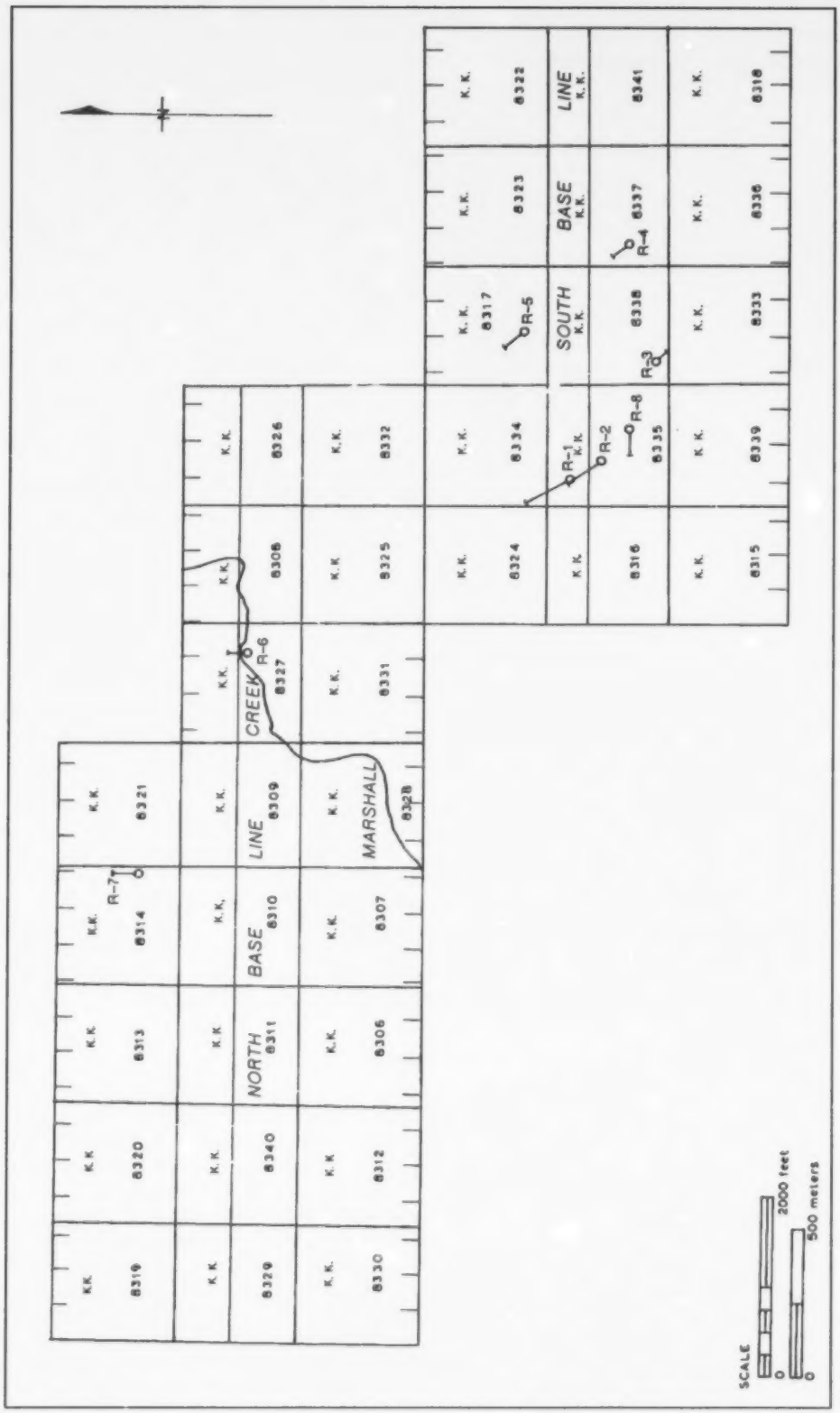

Figure 10. *Location of Prospectors Airways Co. Ltd. (Rip property) drill program.*

TABLE 13. SUMMARY OF DIAMOND DRILLING RESULTS, RIP OPTION OF PROSPECTORS AIRWAYS CO. LTD. (1955) (ASSESSMENT FILES RESEARCH OFFICE, ONTARIO GEOLOGICAL SURVEY, TORONTO).

DDH No. / Inclination / Total length	Claim No.	Rock Type	Conductor	Intersection (core length) in feet
R1-45°/NNW/695'	KK8335	"white quartzite" (probably chert)	magnetite and pyrite	34-189
R2-45 °/NNW/706.6'	KK8335	"white massive quartzite" (most likely chert)	pyrrhotite (40%)	242-343
		IF	pyrrhotite and pyrite (30-80%), magnetite (1-5%),	513-640
		felsic volcanic breccia (felsic fragments, siliceous matrix)	70-90% pyrrhotite 3-5% pyrite, some magnetite	640-681
		sericitic and chloritic banded tuff	30-100% sulphides 10-40% pyrite 20-90% pyrrhotite	684-698
R3-50°/SSE/148'	KK8338	felsic banded tuff (massive, garnetiferous and banded with few visible fragments; matrix mainly chloritic)	graphitic (jet-black) zone sparsely mineralized with pyrite	69-106
R4-45°/N27W/260'	KK8337	"massive white quartzite" (most likely chert)	cherty sulphides 20-80% pyrrhotite, some pyrite, massive to disseminated pyrrhotite	173-179.5
R5-45°/N25W/319.2'	KK8317	sericitic volcanic breccia (angular and subangular fragments in siliceous and sericitic groundmass)	interbanded chert-magnetite-pyrite zones varying from 30 to 100% iron minerals	190-2105
R6-55°/N/214'	KK8327	felsic volcanic breccia cut by a diabase dike between 144.5-253 (tuffaceous and siliceous matrix with sparse fragments and wide sections with very few fragments)	NR	141-197
R7-45°/253'	KK8314	banded tuff to lapilli tuff ("fragments mainly angular and subangular ... most distinguishing feature is repeated occurrence throughout of angular cream colored fragments 1/4 size of peas")	NR	NR
R8-54°/W/407'	KK8335		NR	NR

NR - not reported

area of the old surveyed claims KK26113, KK26118 and KK26119.

In 1955, following a copper discovery by Teck–Hughes Gold Mines Ltd. (now Teck Corporation Ltd.) a large group of four contiguous claim blocks located just south of the Teck property were acquired by: 1) Alator Corporation Ltd. (11 claims), 2) Callinan Flin–Flon Mines Ltd. (12 claims), 3) Geoscientific Prospectors Ltd. (9 claims), and 4) Rich Groups Yellowknife Mines Ltd. (12 claims). This entire group extended south into the adjacent Willet Lake map area (Amukun 1977b); the claim block farthest to the north (Callinan Flin–Flon Mines Ltd.), covered the central part of the current Lynx–Canada Ltd. property. At the end of 1955, Mining Geophysics Corporation Ltd. conducted electrical resistivity surveys on the entire group. Although further exploration was recommended for some of the claim groups, very little variation in resistivity was reported for the Callinan Flin–Flon Mines property, and nothing that suggested massive sulphide mineralization was outlined by the survey (N.B. Keevil, November 17, 1955, File 63.669, AFRO).

Geological interpretation of the property is based upon a few scattered outcrops and is thought to indicate a distal subaqueous environment underlain by tuffs, lapilli tuffs, and associated beds of fine-grained, well-laminated volcanic metasediments.

MACLEAN, D. (15)

D. MacLean of Belleville is the registered owner of 36 contiguous claims (staked and registered after the current field survey) in the area about 1.6 km south of Phillips Lake. These claims are numbered TB464326 to TB464345, TB455787 to TB455789 and TB455791 to TB455803, all inclusive.

The ground is covered by Pleistocene sand deposits; only a few outcrops of metavolcanic rocks were observed by the field party.

McCHARLES, HAROLD (16)

A group of 30 contiguous unpatented claims numbered TB477086 to TB477115, inclusive, straddling the bend on Marshall Creek east of Lake "B", form the McCharles property.

No records of any exploration surveys conducted by the current owner are available, but in the 1955 geophysical survey and subsequent diamond-drill programme of Prospectors Airways Co. Ltd., two of the diamond-drill holes (R6 and R7) were collared on the present McCharles ground. The results of the drilling are summarized under John R. Lill (Property No. 13).

The geology of the property consists of distal submarine pyroclastic deposits with distinct and probably conformable volcaniclastic and chert horizons. Several faults defined by crushed rock—some indicated by the development of fault breccia—are located north of Marshall Creek.

NEW GOLDVUE MINES OCCURRENCE (17)

In 1955, New Goldvue Mines Ltd. held a property in the area south of Lake "B" (*see* Property No. 18) and east and southeast of Little Marshall Lake that extended southwards out of the map area to Deeds Lake (Amukun 1977a). This property then consisted of a group of eighteen contiguous, unsurveyed and unpatented mining claims numbered KK9315 to KK9332 inclusive. Geophysical and geological surveys were conducted over the property and these surveys were followed by a program of diamond drilling.

Geophysical Surveys

Electromagnetic and magnetic surveys were carried out in the months of February and March, 1955, on a grid made up of a west-trending base line and north-trending offset lines, 61 m apart in anomalous areas, but at 122 m intervals over the rest of the property. Five strong conducting zones numbered "A" to "E" were outlined by the surveys (I.C. Christopher and M. Zurowski, File 63.598, AFRO). Anomalies "A" and "B", in the northeastern part of the property, outlined very strong conductors that were suspected by I.C. Christopher to be due to sulphide mineralization. I.C. Christopher also attributed anomalies "C" and "D" to sulphide mineralization rather than to graphite occurrences and recommended a program of diamond drilling to be carried out on the property to test all the zones (I.C. Christopher, May 2, 1955, File 63.598, AFRO).

Geological Survey

The property was mapped during the month of May, 1955, by Michael Zurowski (AFRO), who interpreted the property to be underlain by a series of metamorphosed siliceous sediments (chert) and mafic flows. A heavy gossan zone on claims KK9332 and KK9329 displaying a "hematitic and cellular structure" was thought to indicate pyrite-pyrrhotite sulphides by Zurowski (AFRO), who also reported pyrite mineralization in sheared (mafic) lavas along the north boundary of claim KK9326 (on strike with a strong EM conductor to the east). Three of the five strong EM anomalous areas were reported to be located within the metasediments, while the other two were within the (mafic) lava unit (M. Zurowski, AFRO). The strong zone within the metasediments near the south boundary of claim KK9326 was reported to be flanked by a high magnetic zone, and was interpreted as a sulphide zone flanked by an iron formation or a mafic magnetite-rich rock. The two anomalous zones within the mafic lavas were reported to be on strike with known mineralization (Michael Zurowski, August 12, 1955, File 63.598, AFRO). Because of the geological and geophysical survey results, and because the property could not

be investigated on the surface in view of the extensive overburden conditions, M. Zurowski (AFRO) recommended seven diamond-drill holes totalling a minimum of 610 m. These holes were to intersect anomalous zones at a vertical depth of 46 m.

Diamond Drilling

A total of eight diamond-drill holes were collared on the property, but were not located by the author and his assistants. Two of these holes, totalling 197 m in length, are located in the Deeds Lake area of the Willet Lake map area (Amukun 1977b, p. 78). Of the remaining six holes, four were located on what is currently the property of N.W.T. Copper Mines Ltd., and two were located in the area east of the north shore of Little Marshall Lake. The diamond drilling results reproduced here were reported by Michael Zurowski (January 20, 1956, AFRO).

Diamond Drill Holes nos. 1 and 2 cross-sectioned EM anomaly "A". Whereas Hole No. 1 did not intersect any material to successfully explain the anomaly, Hole No. 2 located 243 m to the northeast of Hole No. 1 and drilled in the opposite direction cut disseminated to massive pyrite-pyrrhotite mineralization. The best sulphide intersection occurred between 38.8 and 46.0 m, was 80 to 100 percent sulphide mineralization and returned minor assay values of copper, silver and trace gold. The drilling indicated that Zone "A" dips flatly to the south.

Diamond Drill Hole no. 3 cross-sectioned EM anomaly "B" and cut two sulphide zones at 42.6 to 72.6' and 125.0 to 134' of the hole. These sulphides consisted of pyrite and pyrrhotite zones which also returned minor assay values for copper and silver, and trace gold values.

Diamond Drill Hole no. 4 tested EM anomaly "C" at depth. No substantial sulphide mineralization to explain the conductor was noted, and the conductor was explained as an indication of a "wet shear". The interpretation is apparently substantiated by a positive physiographic expression which may indicate a fault location.

Drill Holes nos. 5, 7 and 8 were designed to test EM anomaly "D". The conductor was attributed to a graphitic zone containing disseminated pyrite and pyrrhotite.

Drill Hole no. 6 tested EM conductor "E" which was also attributed to a graphitic shear zone containing disseminated pyrite and pyrrhotite sulphides which carried no valuable metals.

The property was probably abandoned because the conductors were explained from outcrops to be due to pyrite-pyrrhotite mineralization carrying no commercial amounts of valuable metal sulphides. The northern part of the property was staked by employees of N.W.T. Copper Mines Ltd. (Property No. 18) in the spring of 1977 just before the current field survey.

Geology of the Property

The current geological survey has confirmed that the area is underlain by a unit of chert/ferruginous chert and iron formation 800 m wide to the northwest, and by a pillowed mafic flow 520 m wide to the southeast. The chert/ferruginous chert unit is best exposed between the two little lakes northeast of Little Marshall Lake. The chert iron formation unit is interpreted to strike northeast towards the area south of Lake "B", where it has been exposed by trenching (*see also* N.W.T. Copper Mines Ltd.).

N.W.T. COPPER MINES LTD. (18)

This company has been active in the area since 1968, when it acquired a part of the Billiton showing which had been extensively tested by Jacobus Mining Corp. Ltd. (*see* also Property No. 9). After completing extensive exploration surveys on the Billiton showing and in other parts in the present map area between 1968 and 1971, N.W.T. Copper Mines Ltd. acquired the Kendon Copper Mines Ltd. property and hence full ownership of the entire strike-length of the Billiton showing. In 1971 and 1972, this company leased out 45 claims covering all of the Billiton showing to St. Joseph Explorations Ltd. and a new company (Giant Gripp Mines Inc.) was formed by the two companies to develop the property. When St. Joseph Explorations Ltd. dropped its option in 1975, N.W.T. Copper Mines Ltd. signed an agreement with Imperial Oil Limited on October 1, 1975, to explore the Billiton showing and all that parcel of land owned by Giant Gripp Mines Inc. (then a wholly owned subsidiary of N.W.T. Copper Mines Ltd.). The history of the development and exploration work of the parcel of land on option to Imperial Oil Limited is presented in the discussion of Property No. 9. Those claims that are outside the option agreements discussed above have been explored solely by N.W.T. Copper Mines Ltd; these occur in three separate parts of the map area and are described below.

Area North of Marshall Lake

In 1970, the northeast corner of the N.W.T. Copper Mines property consisted of a 30-claim group located on the north shore of Marshall Lake. A combined EM-magnetometer survey outlined a major series of conductors trending northeast for 3/4 mile across KK28154, KK28155, KK204279, KK204282 and KK204281 in a band from 120 to 180 m wide (Bayne 1970, p. 14). This anomaly is located along the southern edge of a strong magnetic anomaly, within the gabbroic intrusion, that is interpreted by the author to be a pyrrhotite-pyrite-magnetite zone. This zone appears to have been tested by three diamond-drill holes.

Three minor conductors were also outlined. Five short "x-ray" type drill holes were used to test the conductive zones; only magnetite-pyrrhotite-pyrite zones containing minor amounts of chalcopyrite and sphalerite were intersected "in a mixture of amphibolite and quartzite (probably felsic volcanic breccias)" (Bayne 1970).

Area Around Lake "B"

During the spring of 1977, and just before the beginning of the current field survey, employees of N.W.T. Copper Mines Ltd. staked 16 contiguous unpatented and unsurveyed claims in the map area between Little Marshall Lake and Lake "B". The southern part of this claim group covers the northern area of the New Goldvue Mines occurrence (Property No. 17), and the northern section covers most of the ground that was owned by Fred Koosel of Thunder Bay in 1970.

The Koosel property (File 2.510, AFRO) consisted of eight contiguous and unpatented mining claims that extended into the Sollas Lake area to the east. Between January 15, 1970 and October 10, 1970, magnetometer and electromagnetic surveys were conducted on a grid which covered all eight claims. The grid was made up of a west-trending base line, with north-trending wing lines picketed at 100-foot intervals and spaced 120 m apart.

The magnetometer survey indicated an extensive anomaly with a 700 to 1000 gamma background and highs of 3000 to 10 000 gammas, with associated coincident EM conductive axes trending northwest from the southeast corner of PA204272 to the southeast corner of PA204278, near the south shore of Lake "B". A considerable amount of trenching done in the summer of 1970 exposed oxide-facies iron formation with associated pyrrhotite and pyrite (and minor amounts of sphalerite and chalcopyrite) mineralization in the northwestern half of the conductor, i.e., between line 0+00 and line 20+00W, north of the base line (Fred Koosel, July 2, 1971, File 2.510, AFRO). The magnetometer survey also outlined bodies of diorite, some of which are indicated on Map 2531 (back pocket).

A number of other "good" EM conductors were also outlined and although the trenching explained some of these conductors, Koosel recommended geological examination and diamond drilling to conclusively explain each conductor separately.

According to the current study, this area is underlain by a metasedimentary unit represented predominantly by chert/ferruginous chert and iron formation subunits, which form the easternmost strike extension of the ferruginous unit outlined by diamond drilling carried out by New Goldvue Mines Ltd. The metasedimentary unit conformably overlies a tuff to lapilli tuff country rock. These rocks have been intruded by a diorite body, and the entire rock assemblage has been offset by a major extensive fault traversing most of the map area that runs along Lake "B", where brecciation is evident in the country rocks.

Area South of Lake "A"

Two unsurveyed and unpatented claims numbered TB458966 and TB458967, located 2400 m south of Lake "A", were registered in the name of Robert J. Pelky of Algoma Mills at the beginning of the current field survey. The two claims have since been transferred to N.W.T. Copper Mines Ltd.

There is no record of old exploration work on these two claims, but disseminated chalcopyrite mineralization was observed by the current field party in several gneissic lapilli tuff outcrops on the two claims (not shown on Map 2531).

SAARI, T. (19)

Five contiguous claims were staked in the fall of 1977 after the current field mapping had been completed. The claims are registered in the name of T. Saari of Sudbury, and occur midway between Summit and Phillips lakes. The property is overlain by Pleistocene deposits; there is no bedrock exposure.

STEWART LAKE IRON MINES OF ONTARIO LTD. (20)

Thirty-four surveyed claims have been leased by Stewart Lake Iron Mines of Ontario Ltd. in the northwest corner of the map area, over a deposit of metallic iron.

History

An airborne magnetometer survey conducted in the area during the summer of 1957 outlined a strong anomaly over 5.6 km long that consisted of three peaks, two of which were over 10 000 gammas (W.R. Newman, September 6, 1962, File 63.1177, AFRO). One hundred and twenty-five claims were originally staked and it is not known when the claims were reduced to 34.

A ground magnetometer survey was carried out on the property between December 1, 1957, and December 22, 1957, for Panther International Mining Company Ltd., which owned the ground at that time. This survey outlined several magnetic anomalies. The main anomalous zone had a maximum strength of 71 660 gammas and could be traced for over a length of 731.5 m east-northeast. Between March 12, 1958, and March 24, 1958, the anomalies were tested by three diamond-drill holes totalling 308 m in length (W.R. Newman, AFRO).

The claims were acquired by Stewart Lake Iron Mines of Ontario Ltd. who continued additional drilling in 1959. In the 1959 drilling by Stewart Lake Iron Mines of Ontario Ltd., nine diamond-drill holes totalling 1107 m in length were collared (File 14, AFRO). Additional diamond drilling was conducted between July 6, 1962, and July 26, 1962, when three holes totalling 323 m in length were completed (W.R. Newman, AFRO).

Economic Potential of the Iron Deposit

In utilizing the combined results of geophysical surveys and diamond drilling up to 1959, it was calcu-

lated that a possible and probable tonnage of 35 million t of material containing 30 percent magnetite to a depth of 304.8 m was indicated (W.R. Newman, September 6, 1962, File 63.1177, AFRO). Additional tonnage of iron-rich material was also indicated in the 1962 drilling (Newman, AFRO), but this data is not on file.

The extent of the iron mineralization is well defined on the Toronto Lake Aeromagnetic Sheet (ODM–GSC 1963b), where three peaks (indicated as "GIF" on Map 2531, back pocket) attain maxima of greater than 64 500, greater than 62 000 and greater than 64 000 gammas from west to east.

Geology of the Property

The bedrock is extensively covered by a thick, Pleistocene sand deposit. However, the area is here interpreted to be underlain by metasedimentary bedrock derived by the erosion and redeposition of the thick volcanic material to the south. The iron formation is restricted to this unit on the property.

The iron deposit is unexposed and was therefore not examined by the author and his assistants, but Newman (AFRO) has reported (undoubtedly from drill core examination) that "the iron is in the form of banded iron formations, in a metasedimentary series, for the most part consisting of garnetiferous biotite amphibole schists of the Marshall Lake series." His observation seems to agree with the results of the current survey.

TECK CORPORATION LTD. (21)

Teck Corporation Ltd. is paying taxes for six leased and surveyed contiguous claims numbered KK8113 to KK8114, KK22683 to KK22684 and KK22696 to KK22697, located about 1.2 km south of the east end of Gripp Lake.

History

During the 1954 field season, prospectors of Teck–Hughes Gold Mines Ltd. (now Teck Corporation Ltd.) found a number of chalcopyrite showings about 1.2 km south of the east end of Gripp Lake (AFRO). Early in October, 1954, 36 claims were staked to cover the showing, and after some trenching showed other chalcopyrite mineralization, 36 additional claims were staked. In November of that year, when employees returned to conduct more staking, a staking rush was on and most of the Gripp Lake area was staked. A second group of claims located about 3.2 km north of Gripp Lake was acquired by the company so that by the end of 1954, Teck–Hughes Gold Mines Ltd. owned a total of about 100 claims in the two groups of claims in the Gripp Lake area (Langford 1959).

Between January 13 and February 28, 1955, geophysical work consisting of electromagnetic and magnetic surveys was completed. Diamond drilling

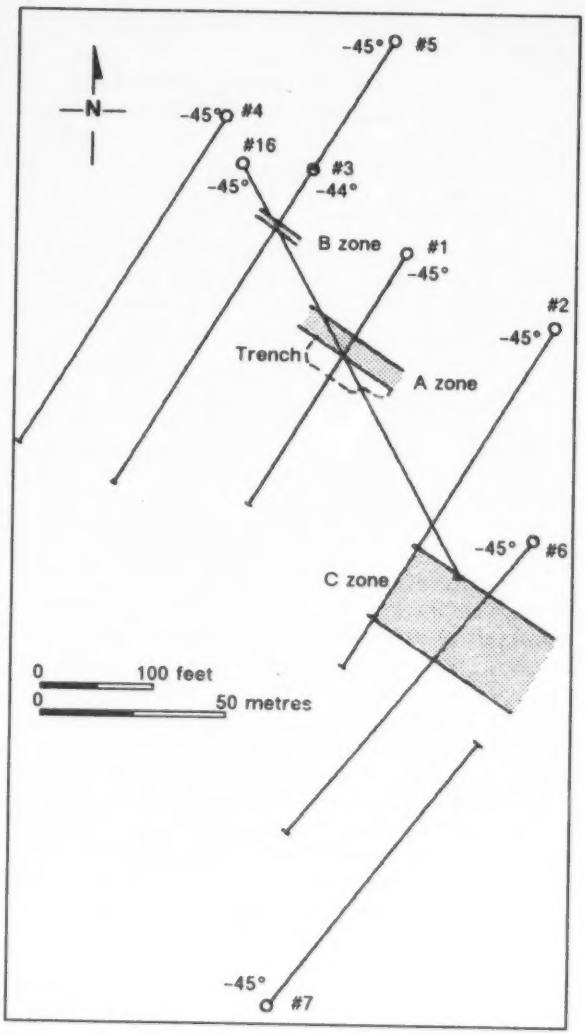

Figure 11. *Location of Teck–Hughes Gold Mines Ltd. (now Teck Corporation Ltd.) drill program about the main showing.*

commenced shortly after the surveys started, and by April 1, 1955, 13 diamond-drill holes with a total length of 17 060 m were collared: seven holes tested the main showing (or "A" zone) (*see* Figure 11; *see also* Langford 1959); two holes tested a small zinc showing (Figure 11); two holes were collared on two small disseminated copper showings; one hole tested a ground EM anomaly; and one hole tested part of the EM anomaly found during an airborne survey (AFRO).

In April and May, 1955, some geological mapping was done, but diamond drilling was suspended until July 26, when seven additional holes were collared to test EM anomalies and two small surface showings. Altogether a total length of 2557 m was completed in 20 drill holes by mid-September, 1955

(A.J. Walker, W.F. Dix and M.H. Frohnberg, File 63.632, AFRO).

In the summer of 1955, F.F. Langford mapped the Gripp Lake area for the Ontario Department of Mines, including the whole Teck–Hughes occurrence. The survey was made as a result of the activity triggered by the Teck–Hughes discovery (Langford 1959).

Between January 25 and March l, 196l, 12 additional holes totalling 1298 m in length were drilled. It is not known whether the drilling program was conducted following geological surveys.

By 1970, the Teck Corporation property was reduced to 22 contiguous claims. During the period between June and September of that year, Geophysical Engineering and Surveys Ltd. conducted magnetometer, self potential and VLF electromagnetic surveys on claim KK22683 (H.D. McLeod, Oct. 26, 197l, File 2.655, AFRO). The surveys failed to outline any significant sulphide concentrations and no further work was recommended. The assessment credit from these surveys probably enabled this claim to qualify for a lease status.

During 1975, it is understood that Teck Corporation Ltd. and Imperial Oil Limited entered into an exploration and development agreement. During the summer months of 1976, a five-man geological party employed by Imperial Oil Limited conducted a detailed survey of the area around Gripp Lake, including the six Teck Corporation Ltd. claims. The geological party and prospectors employed by Imperial Oil Limited successfully outlined numerous new zones with chalcopyrite-sphalerite mineralization by systematically examining garnetiferous amphibolite and gossan zones in the area around and including the Teck showing. Some of the new zones around "Teck Hill" were locally and informally named G-1, G-2, 406 Hill, Gazooma and Cherry Hill (*see* Map 2531, back pocket). An induced polarization survey was carried out in the vicinity of Gripp Lake, and included the Teck showing. The results of the survey covering the Teck Corporation Ltd. ground had not been submitted for assessment credit at the time of writing.

During the summer of 1977, employees of Imperial Oil Limited continued prospecting, trenching, geological mapping and ground geophysical surveying on the property. Towards the end of the field season, one diamond-drilling machine of Morisette Diamond Drilling Ltd. was located in the Teck Hill area and was expected to collar several drill holes on the Teck Corporation property.

Geology of the Property

Prior to the current survey, the rocks of the property were almost without exception described as characteristically monotonous "medium to pale grey, very fine-grained, feldspathic quartzites", but subtle clues indicating the fragmental nature of the rocks were occasionally described by W.F. Dix (Resident Geologists Files, Ontario Ministry of Northern Development and Mines, Beardmore–Geraldton) and by Langford (1959, p. 18).

The most abundant feature of the pyroclastic rocks on the Teck Corporation property, as well as on the adjacent "Cherry" and "406" hills, not previously reported is the extensive occurrence of pumiceous texture in the fragments and in all other nonfragmental rocks. In the outcrops at the "Gazooma" showing, some of the pumiceous and/or scoraceous fragments or rocks display pronounced pumiceous and/or scoraceous texture where vesicles make up 40 to 80 percent of the rock surface. As with the gneissosity, the pumiceous and vesicular nature is apparent on differentially weathered surfaces of the rocks, and is not everywhere visible in the freshly broken rock specimen. Another common feature in the "Teck" and "406" hills is the development of ubiquitous blue quartz "eyes". The origin of these quartz phenocrysts or porphyroblasts is unknown. Sericite schist occurs extensively in the rocks of the trench on the main zone and elsewhere on the property.

Structural Geology of the Property

The metavolcanic and derived metasediments and the sulphide deposits which they contain seem to have undergone several periods of folding. The property is located on the south limb of a regional anticlinal structure which has been interpreted from a few reliable top directions determined by pillow facings to the northeast, by cleavage-bedding relationships, and by several reliable cross-beds and graded beds in the metasediments to the south. Several later folding features were recognized on the property and at many locations on the surrounding ground, in the form of 5 to 10 m (wavelength) fold pairs, drag folds, chevron folds and complex crenulations. In many of the exploration trenches on the property and in the adjacent area, base metal sulphide mineralization is concentrated at the noses of the minor folds. The mineralization appears to have been remobilized and concentrated by later folding so that fold structure and particularly plunge attitudes play an important role in the delineation of zones of sulphide mineral concentration.

Faults and shear zones are the most obvious structural features throughout the property and the surrounding area (*see* Map 2531, back pocket), and are responsible for the development of sericite schists and structural offsets on the property.

Description of the Deposit

The Teck Corporation showing has not been tested in adequate detail to estimate the potential tonnage of economic material. A total of 3856 m of core from 32 holes drilled in 1955 and 196l outlined four zones of mineralization (AFRO). The main or "A"

zone (*see* Figure 10), located 1.2 km south of Gripp Lake and 244 m east of the Nipigon Provincial Forest Reserve boundary, is 4.5 to 6 m wide and was exposed in only two trenches about 6 m apart (W.F. Dix, 1955, AFRO; Langford 1959, p.7). In the trenches, two sulphide-rich bands about 0.5 to 1.5 m wide with an exposed length of 30 to 35 m contained, according to a visual estimate by W.F. Dix and also reported by Langford (1959, p. 17), 15 to 25 percent chalcopyrite with traces of pyrite, pyrrhotite and sphalerite (*see also* Table 7). The surrounding rocks contain disseminated flecks of chalcopyrite, which have been reported by Langford (1959, p. 18) to constitute 5 to 10 percent of the rock. Sulphide stringers (1 by 4 to 5 mm) are parallel to the foliation or banding, and in the sulphide zones (which are largely represented by chalcopyrite) chalcopyrite occurs as small flecks and masses interstitial to the quartz grains, and appears to replace biotite and possibly feldspar (W.F. Dix, 1955, AFRO). The drill core from the main or "A" zone was reported by W.F. Dix (1955, AFRO) to lack stratigraphic markers; thus correlation between holes and mineralized zones was difficult. This phenomena was complicated by the erratic distribution of the mineralized zones and therefore Langford (1959, p. 18) stated:

> In drill core the rocks and sulphides show the same relations as seen on surface. Brecciation is more easily seen in the core, much of the breccia is devoid of sulphide mineralization. Amphibolite bands are scattered and seem to have been more favourable for sphalerite than is the quartzite. The drill plan shows the scattered nature of the sulphide zones. Drill hole no. 1 picked up a narrow zone but no correlation was established with the "A" zone as seen in the trenches.

The "B" zone, which is not exposed on the surface, was found by geophysical and diamond-drill surveys and is located about 30 m north-northwest of the "A" zone which it resembles in character. The "B" zone is less than 3 m wide (W.F. Dix, 1958, AFRO). It was reportedly intersected by drill holes 1, 3 and 5, but was missed by drill holes 2 and 4 (Langford 1959, p.18).

The "C" zone, the largest but weakest mineralized zone, is located about 61 m south-southeast of the "A" zone which it resembles in character, and was reportedly outlined by drilling (holes 6 and 7). Although much wider (15 m), this zone was found to be of lower grade than the "A" zone.

The "D" zone was located between 182 and 305 m east-northeast of the "A" zone, and was found after trenching to consist of sphalerite and chalcopyrite-bearing amphibolite stringers in felsic pyroclastic rocks (then considered to be quartzites). According to W.F. Dix (AFRO), "The mineralization appears to be associated with fractures in an amphibolite band in the Marshall Lake Series. The main sulphide is sphalerite with some chalcopyrite and pyrite. Some carbonate appears to be present. This showing is very small and pinches out rapidly along strike depth."

This zone, also known locally as the "zinc zone", was not located by the field party during the field season, but another trench in this vicinity containing pyrite and disseminated chalcopyrite was mapped. No details of old exploration surveys of the "zinc zone" and the "pyrite zone" are available.

Some of the assay results of the mineralized rocks collected by the current field survey from outcrops and trenches on the Teck Corporation property are given in Table 7.

TERNOWESKY, JOHN (22)

At the end of the 1977 field season, John Ternowesky of Thunder Bay acquired three blocks of claims in the vicinity of Gripp Lake (two blocks) and south of Deeds Island in Marshall Lake (one block). The two groups of claims in the vicinity of Gripp Lake were made up of an eight-claim block located at the southeast border of the Nipigon Forest Reserve, south of the Gripp River (TB455386 to TB455392 inclusive), and a four-claim block located at the intersection of the 7th Base Line (Mileage 145) and the Nipigon Forest Reserve Line (TB455394 to TB455397 inclusive)

No record of any past exploration work is available for the Gripp Lake groups, but it is known that during the field season some amount of prospecting and rock trenching conducted on this ground uncovered sulphide zones containing disseminated chalcopyrite.

The Marshall Lake claim group is made up of ten contiguous unpatented claims numbered TB459023 to TB459032, inclusive, and was at the beginning of the field season registered in the name of Ronald Robert Smith of Thunder Bay. In 1955, Yellowknife Bear Mines Ltd. conducted a resisitivity survey over a larger area (also covering properties 8 and 16) that included all of this property (File 63.672, AFRO).

A number of local anomalies were outlined by the resistivity survey. Sufficiently good conductors to warrant further investigation were recognized (N.B. Keevil, J.C. Frantz, November 15, 1955, File 63.672, AFRO). Although the anomalies were recommended to be "investigated on the ground by geological mapping to be followed by trenching or diamond drilling" (five locations suggested), no subsequent results of additional work are available. Several magnetic pyritiferous zones and ferruginous metasedimentary bands were mapped during the field season that seem to coincide with the localities of the several conductors outlined by the resistivity survey. In 1962, Sheridan Geophysics Ltd. conducted ground magnetometer and EM surveys on a large claim group (182 claims) including the property then belonging to Jacobus Mining Corp. Ltd. (*see* Property No. 9). Several anomalous areas of con-

ductivity were outlined by the surveys, but no record of further exploration work was reported by this company. In 1965, Vincent Feeley drilled three diamond-drill holes totalling 110 m in length in the area of the current claim TB459029. Traces of base metals were intersected, in addition to pyrite and pyrrhotite with or without graphite and magnetite (File 18, AFRO). Iron sulphide mineralization has been outlined in this area by Langford (1959).

The rocks of this area have been interpreted to be proximal to source area "B" (*see* Map 2531, back pocket) in that it consists almost exclusively of air-fall breccia and/or tuff breccia to pyroclastic breccia. The air-fall breccia consists of broken felsic bombs and lapilli (frequently rimmed by mica or amphibole-filled vesicles) set in a chloritic matrix.

THORSTEINSON, DAVID (23)

At the beginning of the 1977 field season, David Thorsteinson of Beardmore was the registered owner of two groups of claims in the map area. One of these groups consisted of 27 unsurveyed and unpatented claims numbered TB459308 to TB459309 and TB459798 to TB459822, all inclusive, located southeast of the Nipigon Forest Reserve Land; this group was transferred to Lynx–Canada Ltd. later in the same year. The remaining claim block consisted of 25 contiguous unsurveyed and unpatented claims numbered TB459283 to TB459307, inclusive, located in the Lake "C" area east of Summit Lake; this group was still registered to David Thorsteinson at the end of the field season.

There is no record of exploration work having been conducted on this property to date.

The property is located over a geological boundary between the Summit Lake stock and pyroclastic rocks. Both rock types are cut by a north-trending porphyritic diabase dike.

WEIRMER, M. (24)

Sixteen contiguous unsurveyed and unpatented claims numbered TB455827 to TB455842, inclusive, were staked in the fall of 1977 following the completion of the field mapping for this study, and are registered to M. Weirmer of Sudbury. The claim group is located east of the Nipigon Forest Reserve Line, 4877 m due west of Phillips Lake.

The claim group is entirely overlain by sand deposits.

RECOMMENDATIONS FOR FUTURE EXPLORATION

The concept of close spatial association between coarse felsic pyroclastic rocks and massive sulfide ores has not been extensively applied as a base metal exploration tool in the Marshall Lake–Gripp Lake area, probably because these rocks were not previously known to be widespread in the area. Detailed mapping of fragment size and distribution within the pyroclastic rocks following the method proposed by Fox (1977) may be a useful base metal exploration tool because of the widespread distribution of lapilli tuffs and tuff breccia.

The "Main" showing (the Billiton showing), with a total of over 1 300 000 t of indicated and inferred mineralization is probably of epigenetic intravolcanic origin, but the mineralization appears to have been remobilized and concentrated by later folding. The copper-lead-zinc mineralization is thickest and of improved grade at the hinges of minor folds, and appears to occur as rods that plunge to the east. Rock exposure south of the Gripp and Marshall lakes, where most of the mineralization has been found to date, is about 60 percent. This makes it possible to conduct a detailed structural study. In this and other deposits in the area, therefore, recognition should be given to fold structures (of minor as well as of large scale) and particularly plunge attitude, in any attempt to delineate zones of sulphide mineral concentration.

The area north of Gripp and Marshall lakes, and on the southern border of the map area, is covered by an extensive deposit of Pleistocene material as thick as 15 m in areas around Phillips Lake. This feature may serve to make geophysical exploration difficult. Consequently, the author recommends deeper penetrating geophysical surveys such as vertical-loop or horizontal-loop frequency electromagnetic surveys. Although almost all of the better showings to date have been located by conventional prospecting methods, geophysical survey methods capable of responding to disseminated mineralization (such as induced polarization) have shown some favourable results, such as on the Giant Gripp–Imperial Oil property.

Base metal mineralization is confined to the finer grained pyroclastic rocks (tuffs and lapilli tuffs) within the centre of the Marshall Lake anticline. Structural and geophysical data indicate that the strata are folded about the anticline towards the northwest. This suggests that the unit at the main showing, and at the newly exposed copper-bearing trench south of the Gripp River, may possibly be traceable from Gripp and Marshall lakes northwest through Phillips Lake, along the north limb of the fold. If mineralization is associated with this unit of finer grained pyroclastic rocks, then prospecting may be warranted northwest of Marshall Lake, south and southwest of Lake "A" and Phillips Lake, and possibly beyond.

References

Amukun, S.E. 1977a. Little Marshall Lake area, district of Thunder Bay; *in* Summary of Field Work 1977, Ontario Geological Survey, Miscellaneous Paper 75, p.60-63.

—— 1977b. Geology of the Willet Lake area; Ontario Geological Survey, Open File Report 5234, 101p.

—— 1977c. Geology of the Tashota area, district of Thunder Bay; Ontario Geolological Survey, Report 167, 90p.

—— 1978. Precambrian geology, Little Marshall Lake area, district of Thunder Bay; Ontario Geological Survey, Preliminary Map P.1561, scale 1:15 840.

Amukun, S.E., Treacher, K.W. and Papertzian, V.C. 1976. Precambrian geology, Willet Lake area, district of Thunder Bay; Ontario Division of Mines, Preliminary Map P.1092, scale 1:15 840.

Anderson, C.A., and Nash, J.T. 1972. Geology of the massive sulfide deposits at Jerome, Arizona-a reinterpretation; Economic Geology v.67, no.7, p.845-863.

Aramaki, S. 1961. Classification of pyroclastic flows; International Geology Review, v.3, p.518-524.

Bayne A.S. 1970. Report on examination and feasibility study, N.W.T. Copper Mines Ltd., Marshall Lake area, district of Thunder Bay, Ontario, Canada; an unpublished report to the president and directors, dated October 23, 1970, 27p., Assessment Files Research Office, Ontario Geological Survey, Toronto.

Brown, W.L. and Bray, R.C.E. 1960. The geology of the Geco mine; Canadian Mining and Metallurgy Bulletin, v.53, p.3-11.

Chayes, F. 1952. Notes on the staining of potash feldspar sodium cobaltinitrate in thin sections; American Mineralogist, v.37, p.337-340.

Fisher, R.V. 1966. Rocks composed of volcanic fragments and their classification; Earth-Science Reviews, v.1, p.287-298.

Fox, J.S. 1977. Rapid pyroclastic mapping in base metal exploration; Canadian Institute of Mining and Metallurgy Bulletin, v.70, no.779, p.173-178.

Franklin, J.M., Kasarda, J. and Poulson, K.H. 1975. Petrology and chemistry of the alteration zone of the Mattabi massive sulphide deposit; Economic Geology, v.70, no.1, p.63-79.

Gross, G.A. 1965. Geology of iron deposits in Canada, general geology and evaluation of iron deposits; Geological Survey of Canada, Economic Geology Report no. 22, 181p.

Hogg, N. 1955. Geology of Godfrey Township; Ontario Department of Mines, Annual Report, 1954 v.63, pt.7, p.1-55.

Hopkins, P.E. 1916. Kowkash Gold area; Ontario Bureau of Mines, Annual Report, 1916, v.25, pt.1, p.264-274.

—— 1917. The Kowkash Gold area (second report); Ontario Bureau of Mines, Annual Report, 1917, v.26, p.190-226.

Hutchinson, R.W. 1973. Volcanogenic sulfide deposits and their metallogenic significance; Economic Geology, v.68, no.8, p.1223-1246.

Irvine, T.N. and Baragar, W.R.A. 1971. A Guide to chemical classification of the common volcanic rocks; Canadian Journal of Earth Sciences, v.8, p.223-248.

Jensen L.S. 1976. A new cation plot for classifying subalkalic volcanic rocks; Ontario Division of Mines, Miscellaneous Paper 66, 22p.

Kindle, L.F. 1931. Kowkash-Ogoki gold area, district of Thunder Bay; Ontario Department of Mines, Annual Report, 1931, v.40, pt.4, p.55-104.

Langford, F.F. 1959. Geology of the Gripp Lake area, district of Thunder Bay; Ontario Department of Mines, Annual Report, 1958, v.67, pt.3, p.1-22.

Larsen L.R. and Webber, G.R. 1977. Chemical and petrographic variations in rhyolitic zones in the Noranda area, Quebec; Canadian Institute of Mining and Metallurgy Bulletin, v.70, no.784, p.80-93.

Mackasey, W.O., Blackburn, C.E. and Trowell, N.F. 1974. A regional approach to the Wabigoon-Quetico belts and its bearing on exploration in northwestern Ontario; Ontario Division of Mines, Miscellaneous Paper 58, 24p.

Milne, V.G. 1969. Progress report on a field study of Manitouwadge area ore deposits; Canadian Institute of Mining and Metallurgy, Annual Meeting, April 1969 (presented paper).

Niem, A.R. 1977. Mississipian pyroclastic flow and ash-fall deposits in the deep-marine Quachita flysch basin, Oklahoma and Arkansas; Geological Society of America, Bulletin, v.88, p.49-61.

ODM-GSC 1963a. Elbow Lake sheet, Thunder Bay District, Ontario; Ontario Department of Mines-Geological Survey of Canada, Aeromagnetic Map 2137G, scale 1:253 440.

—— 1963b. Toronto Lake sheet, Thunder Bay District, Ontario; Ontario Department of Mines-Geological Survey of Canada, Aeromagnetic Map 2138G, scale 1:253 440.

—— 1965. Nakina sheet, Thunder Bay District, Ontario; Ontario Department of Mines-Geological Survey of Canada, Aeromagnetic Map 7120G, scale 1:253 440.

Pye, E.G. 1968. Geology of the Crescent Lake area, district of Thunder Bay; Ontario Department of Mines, Report 55, 72p.

Pye, E.G., Harris, F.R. Fenwick, K.G. and Baille, J. 1965. Tashota-Geraldton sheet; Ontario Department of Mines, Map 2102, scale 1:253 440.

Ridler, R.H. 1973. Exhalite concept, a new tool for exploration; Northern Miner, Nov. 29, p.59-61.

Sangster, D.F. and Scott, S.D. 1976. Precambrian, strata-bound, massive Cu-Zn-Pb sulphide ores of North America; *in* Handbook of strata-bound and stratiform ore deposts, K.H. Wolf (Ed.), Elsevier, Amsterdam, 585p.

Sangster, D.F. 1972. Precambrian massive sulphide deposits in Canada, a review; Geological Survey of Canada, Paper 72-22, 44p.

Sclar, C.B. and Fahey, J.J. 1972. The staining mechanism of potash feldspars and the origin of hieratite; American Mineralogist v.57, no.1-2, p.287-291.

Self, S. 1976. The Recent volcanology of Terceira, Azores; Joural of the Geological Society of London, v.123, p.645-666.

Smith, R.L. and Ross, C.S. 1966. Ash-flow tuffs: their origin, geologic relations and identification; United States Geological Survey, Professional Paper 366, 81p.

Solomon, M. 1976. "Volcanic" massive sulphide deposits and their host rocks. A review and/or explanation; Economic Geology, v.6, p.21-54.

Spence, C.D. 1975. Volcanogenic features of the Vauze sulphide deposit, Noranda, Quebec; Economic Geology, v.70, p.102-114.

Spence, C.D. and De Rosen-Spence 1975. The place of mineralization in the volcanic sequence at Noranda, Quebec; Economic Geology, v.70, p.90-101.

Suffel, G.G., Hutchinson, R.W. and Ridler, R.H. 1971. Metamorphism of massive sulphides at *Manitouwadge*, Ontario, Canada; Society of Mining Geology, Japan, special issue no.3, p.235-240.

Turner, J.F. 1968. Metamorphic petrology, mineralogical and field aspects; McGraw Hill, New York, 1968, 524p.

Vokes, F.M. 1969. A review of the metamorphism of sulphide deposits; Earth-Science Reviews, v.6, p.99-143.

Wentworth, C.K. 1927. A scale of grade and class terms for clastic sediments; Journal of Geology, v.30, p.377-92.

Zoltai, S.C. 1965. Glacial features of the Quetico-Nipigon area, Ontario; Canadian Journal of Earth Science, 2, p.247-269.

—— 1967. Glacial features of the north-central Lake Superior region, Ontario; Canadian Journal of Earth Science, v.4, no.3, p.515-528.

MAPS
NOT
FILMED

CARTES
OMISES